ENGINEERING NEWS

A SERIOUS accident due wholly to carelessness occurred Feb. 14 on the elevated road now being built on Broadway, Brooklyn, by the Union Elevated Railway Co., despite the warning from a very similar accident on the Flatbush avenue section of the same road, mentioned in ENGINEERING NEWS, Nov. 19 and 26, 1887. The columns and transverse girders had been erected, and the contractors were putting in the longitudinal girders, having reached Sumner Ave., where the accident occurred. The four longitudinal girders of one section had been put in place and fastened by a few rivets or bolts; but instead of waiting till they had been permanently secured, the traveler and hoisting engine were moved onto the girders, and a girder for the next section lifted; the derricks rested on the last section on which the longitudinal girders had been placed, and the traveler and engine on the one behind it. The girder had only been raised a short distance when all four of the longitudinals on which the traveler and engine rested became displaced, broke the temporary fastenings and fell into the street, crushing a street car and a wagon. Four men were killed and about 10 injured; 3 horses were killed. It appears to have been a regular practice to use the structure before it was properly secured. The columns were not permanently fastened at the bottom, in order to allow of adjusting the rivet holes of the girders and it is probable that the strain caused by lifting the girder (or moving the traveler), resulted in the displacement of one of the transverse sections, or in jarring the longitudinal girders off their seats, or both.

THE columns of the structure consist of two latticed channel-irons, on the curb line of the street. On them rest transverse plate girders. Between the transverse girders are 4 longitudinal plate girders, about 60 ft. long. The upper part of the end of these girders has a projection which rests on the transverse girder, and the bottom rests on a bracket riveted to the web of the transverse girders. The last set of longitudinal girders, next to the section which had fallen, had not been fastened to the transverse girders, and shortly after the accident men were put at work to secure them, as they were in a very unsafe position, one of the columns having been forced considerably out of plumb. Up to a few sections back the structure is completed and painted, and the contractors were evidently in haste to push ahead, the erecting gang being closely followed by th riveters. The contractors are J. B. & J. M. CORNELL; the Flatbush avenue section was built by the Pencoyd Iron Co. The foreman in charge of the work was arrested under a charge of manslaughter, but as he was probably acting under orders it would have had a healthier effect to have gone a little higher up.

THE structure itself is of wretchedly "cheap and nasty" design, as are most of the Brooklyn elevated lines; so very cheap and so very nasty that those of New York, which have not generally been regarded as models of fine bridge work, shine by comparison. Perhaps as bad a specimen as any in the city is that directly opposite the City Hall on the new Fulton St. line, which is really a shocking example of the sacrifice of almost every principle of sound construction to cheapness of first cost. If trouble does not arise within a few years from the bad design of a large proportion of the elevated bridge work which has been put up in Brooklyn, we shall be greatly surprised.

THE one respect in which the passenger accommodation of the Brooklyn Bridge has so far been above the level of that offered by private companies, has been that the cars were not disfigured by advertisements. The Trustees, apparently feeling that such singularity savored somewhat of arrogance and had a certain incongruity with the other conditions of traffic on the bridge, resolved at their last meeting that they would *not* accept $2,500 per year for the privilege of plastering all their cars with advertisements, but would sell the eyes of the public while under their control to the highest bidder, and get *perhaps* $10,000 per year.

Mr. FRANK CONGER, a director of the Tehuantepec Ship Railway is urging before the House Committee at Washington, the passage of a bill to charter his company. He states that his company is equally entitled to such a charter with the Nicaragua Canal Co., and common justice demands that the companies should recieve equal favors.

The rapid growth of New York is gradually enhancing the value of real estate in its neighborhood, and the latest indication of this is a measure now before the New Jersey Legislature proposing to convert a portion of the flats and swamps in front of lower Jersey City into solid ground. The scheme suggested is to fill in a new shore line from Constable's Hook, around Robin's Reef Light, to Caven Point; provide this new front (in 30 ft. of water) with a system of docks, and fill in the ground between these docks and the present hard ground. This bill, if passed, would take 12 sq. miles from New York Bay, and convert this now shallow area to a useful purpose.

BOTH of the Societies of Architects in this city have protested against the way in which it was proposed to seek the assistance of architects for designing the proposed extensions of the City Hall, the Mayor, and Sinking Fund Commissioners being their own architects up to the point where *they* felt their knowledge was sufficient, and leaving to architects the rest, under further rather unusual conditions. The whole project was one of questionable wisdom, and we are glad to believe that it is for the present dead.

THERE is a vague rumor afloat, quoted by us from the *Chicago Journal of Commerce*, to the effect that an irrigation company in Arizona is about to erect a dam "110 ft. high, 400 ft. long and 130 ft. thick at the base." It is to store 1,000 million gallons of water for irrigation and placer washing.

THE Commissioners of the Land Office of the State of New York have had prepared a series of maps in atlas form showing the entire shore line of King's County, and a similar series of maps is being prepared for Richmond County. These maps are of great value in the issuing of grants for land under water to the owners or representatives of the adjoining shore lands.

THE Russian Government is making rapid progress in the construction of military railroads in Turkestan. Trains are now running accross the Oxus river, the new bridge at Charjui being completed and the line will now be pushed through Bokhara and Samarcand to the Afghan frontier.

THE city of Boston has not yet disposed of its "3,945 unserviceable water meters." They appear to be pretty dead stock.

THE Grand Trunk Railway grade crossings in Montreal are about to be taken out at a cost of about half a million dollars. What the Canadian Pacific is doing there will be shown in our next issue.

A SINGULAR locomotive boiler explosion, provoked by a derailment, took place last week on the Delaware, Lackawanna & Western R. R., just beyond Secaucus, N. J. The derailment occurred an appreciable time before the explosion came. The train and engine were both heavy and the speed slow. The engine was almost a total wreck, but both men of its crew escaped.

ANOTHER engine exploded on the Rumford Falls & Buckfield Railroad in the round house at Canton, Me., Feb. 1.

THE most serious railway accident of the week occurred Feb. 9, on the St. Paul, Minneapolis & Manitoba Railway, near Clontarf, Minn. A double header passenger train was derailed by a broken flange on one of the driving wheels. Two persons were seriously injured. Two other accidents caused by broken wheels are reported, and another by a broken axle.

A LANDSLIDE occurred at Fites' Eddy, Md., on the Port Deposit & Columbia branch of the Philadelphia, Wilmington & Baltimore Railroad, Feb. 9, and traffic was delayed for some time.——The dam of the Rock Springs water-works reservoir, above Blairtown, Wyo., burst Feb. 2. The water having leaked and washed out around the pipe through the dam.

THE following bridge accidents are reported: On Feb. 6 the trestle work of the large bridge over Little Patuxent river, near Laurel, Howard county, Md., was carried away by the ice.——On Feb. 8, a stone arch bridge over Sandburg creek, at Ellenville, N. Y., gave way under a 10-ton load of stone. The loss is estimated at $3,000.——On Feb. 11 a freight train on the Chicago, St. Paul, Minneapolis & Omaha Railway went through a trestle one mile west of Blakely, Minn.

CAPT. S. A. DAY, U. S. A., in a paper at the American Institute Polytechnic Section on "The Rifle," suggested that the "electric fire" in place of the percussion lock would be as marked an improvement over percussion as that was over the flint lock. A small battery is stored in the stock of the rifle, and it will furnish a current when the trigger is pulled for thousands of shots. "This," said Capt. DAY, "is the rifle of the future, and it makes possible the use of the highest explosives."

THE grade of the Kansas City cable line on which the recent runaway accident occurred was 18¼ per cent., against 16 per cent. on the St. Paul line which lately had a similar accident. They were provided (at Kansas City) with a powerful "wedge" brake as well as the ordinary kind, and also a track brake, and an extra brakeman rides up the heavy grades to assist in handling them. The wedge brake only acts against forward motion however, and all three brakes appear to rely only on the gravity of the car for their total power. The only proper brake on such heavy grades is a toggle-joint grip on the side of the rail-heads, by which unlimited power may be had with the lightest car.

AN invention which we apprehend to be one of considerable practical value in its idea, if well and simply worked out, was tested last week on the Cincinnati, Wabash & Michigan road, viz. MCCOY'S track sand sweeper, to clean the rails of sand again behind the drivers. The tests are reported to have shown a considerable reduction of train resistance, and we have no doubt correctly if the rail was well cleaned.

IN 1881 the Missouri Legislature passed a statute requiring that at all places where one railroad crossed another, there should be erected by both roads jointly, or by each separately, a depot, under a penalty, which goes to the school fund. A suit under this statute has just reached one stage in the United States Circuit Court at Kansas City, the court holding that the statute is constitutional, and that it is no defense by the railroad against which the action is brought that the other road is not also sued. Neither is released from liability by the failure of the other.

WITHIN the month the Corpus Christi & Padre Island Harbor Co. has been chartered with a capital stock of $10,000,000. The purpose of the company is "to construct, own and maintain a harbor" by building piers and breakwaters extending into the Gulf of Mexico, and thus provide accommodation for vessels of all kinds. The incorporators are—JNO. IRELAND, A. HAUSL, JOHN WILLETT. D. M. MURPHY, JAS. H. FRENCH, E. D. L. WICKES, H. P. BEE, etc. The project includes crossing the Laguna de la Madre, 4 miles across and with less than 1 ft. of water; crossing Padre Island and then building out 3300 ft. into the Gulf to 30 ft. of water. From the end of this sea-wall another sea-wall or breakwater will extend south about 3000 ft. parallel with the shore and enclosing the harbor of refuge and the wharves, which latter will be on the inner faces of these two sea-walls. Railway tracks will connect each wharf with the main land.

THE American Atlantic & Pacific Ship Canal Co. is protesting at Washington against the passage of the bill incorporating the Maritime Canal Co. of Nicaragua. The protesting company claims that it has the exclusive right to build and manage a ship canal across Nicaragua and can finish it in three years if not interfered with by the company objected to.

Report on the Duty and Capacity Tests of the Gaskill Pumping Engine at the Spring Garden Pumping Station, Philadelphia, Pa.

The following is the report on the duty and capacity tests of the 20,000,000 galls. Gaskill engine, at the Spring Garden Pumping Station, Philadelphia, Pa. This report was, on Jan. 10, 1888, presented to JOHN L. OGDEN, Chief Engineer, by JOHN E. CODMAN, expert for the Phila. Water Dept., and F. T. HOLLY, for the Holly Mfg. Co.

By the requirements of the contract, a capacity and a duty test were to be made—the latter within two months after the engine should have been put in operation. By mutual agreement both tests were made at the same time. The duty required by the specifications was one hundred millions (100,000,000) of foot pounds, with a consumption of one hundred (100) pounds of coal on the basis of ten (10) pounds of water evaporated per pound of coal; the duty to be computed by the following formula:

$$\frac{P \times N \times H \times 100}{W} = \text{duty.}$$

in which P = pounds of water delivered per stroke, N = the number of strokes during trial, H = total fluid resistance including static and frictional heads measured to the surface of water in pump well, allowing one pound for friction through the pump and passages, and W = number of pounds of coal on the basis of 10 pounds of water evaporated per pound of coal. The duty guaranteed by the contractors was one hundred and ten millions (110,000,000) of foot pounds.

The trial of 24 hours duration began at 8 A.M. Tuesday, November 29, and terminated at 8 A.M. Wednesday, Nov. 30, 1887.

Method of Conducting Test.—It was agreed to take half-hourly observations from all the attachments on both boilers and engine. For this purpose one steam gauge on the engine was tested for reading steam pressure thereon; one steam gauge out of the five inspected was selected and tested for reading steam pressure on the boilers; one pressure gauge on the engine was tested for reading the water pressure; and the distance from center of gauge to surface of water in forebay measured.

The coal consumed was weighed in the small cars used at the station, and after inspection was run into the boiler room. The firing was done by the regular men.

The water for the boilers was pumped into a wooden tank capable of holding about 2,700 lbs., weighed, and run thence into an iron tank of about 9,000 lbs capacity, from which an attachment was made to the pumps feeding the boilers. Both tanks were set on platform scales, which had been inspected and corrected.

In the agreement a clause, voluntarily made by the contractors, stipulated that the engine while on test should pump all feed water into boilers, *and no allowance be made for steam so used.* For this purpose four plunger feed pumps were connected to a rocker arm attached to a trunnion on the walking beam center. Two of these were regulated to pump water continuously into the boilers. In calculating the duty *no allowance has been made for this quantity of work*, aggregating, during the 24 hours, 66,000,000 foot pounds. In making a comparison of duty tests with other engines it is only fair to state that this amount of work is commonly done by an extra donkey pump supplied with steam from another set of boilers kept running for this purpose, thus involving not only extra labor but also coal and boiler capacity.

It was agreed to check the water observations in the large tank at the end of each hour. For this purpose a gauge reading in inches from the bottom of the tank was so placed that the height of water could be plainly seen. At the beginning of the test the height of the water was read on the gauge, and at the end of each hour the water was brought to the same point, and the quantity for the hour weighed out of the small tank and checked off by the observers. The specifications required that 10 lbs. of water should be considered as a pound of combustible, therefore particular attention was given to the accuracy of the observations on the amount of water weighed out to the boiler.

The high and low pressure cylinders are both steam jacketed with live steam from the boilers. In the ordinary running of the engines, the condensed water resulting therefrom is carried through a coil heater and steam trap and pumped back into the boilers, increasing the temperature of the feed water to nearly 212° F.

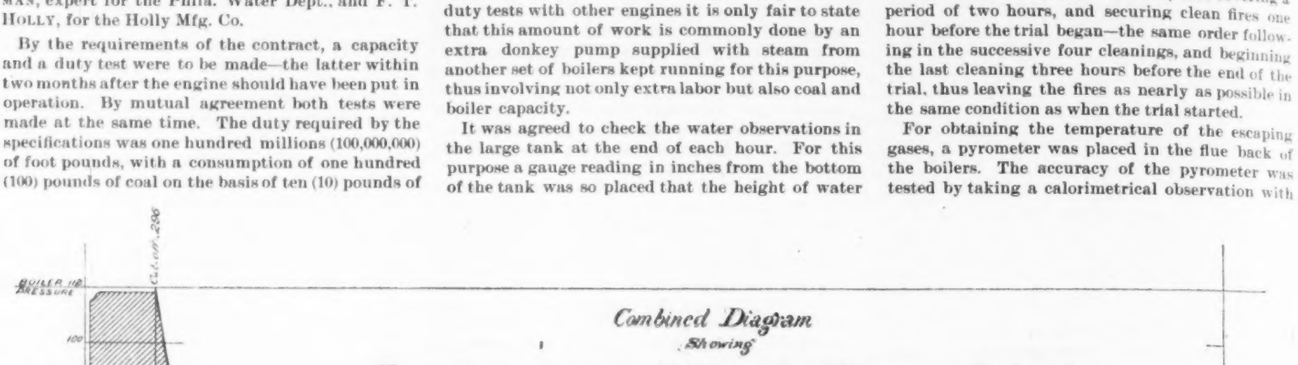
On the trial this jacket water was cut out from the feed pumps and a steam trap so placed that the discharge from it could be collected in a barrel placed upon platform scales, weighed and checked every hour. In calculating the duty this jacket water has not been deducted from the amount actually pumped into the boilers and charged to the contractors, nor was it permitted to be *trapped* back into the boilers without being accounted for.

The specifications requiring the duty to be calculated from 10 lbs. of water equivalent to 1 lb. of coal, made the engines and boilers two separate plants. The management of the boiler fires and all the attachments in the boiler room were under the direction of the Bureau of Water, but all observations were taken jointly.

The five boilers used in furnishing steam were made from designs and drawings prepared in the Bureau, and were calculated to carry 100 lbs. of steam pressure, and to furnish a sufficient supply of steam to enable the engine to fulfill the contract. On a preliminary trial it was found that four boilers would furnish ample steam for the engine, but it was considered best to use the five in order to maintain a constant steam pressure in cleaning fires.

It was agreed to clean the fires four times during the 24 hours and weigh all ashes and clinkers dry. In order to bring the fires to the same condition when the trial ceased as they were in the beginning, directions were given to clean the fires in regular succession three hours before the trial began, cleaning two furnaces at one time in the several boilers at intervals of one-half hour each, and covering a period of two hours, and securing clean fires one hour before the trial began—the same order following in the successive four cleanings, and beginning the last cleaning three hours before the end of the trial, thus leaving the fires as nearly as possible in the same condition as when the trial started.

For obtaining the temperature of the escaping gases, a pyrometer was placed in the flue back of the boilers. The accuracy of the pyrometer was tested by taking a calorimetrical observation with a known weight of iron and a given quantity of water of known temperature and found to be correct within about 20° F. An attachment was made to the steam-pipe to take calorimetrical observations on the quality of the steam.



The coal used was rather an inferior quality of Schuylkill nut containing about 25 per cent. of clinker and ash, besides being very wet. A sample of 370 lbs. was taken and dried upon the boiler flue for 24 hours and found to contain 6 per cent. of moisture—the evaporation of which is credited to the boilers and is shown in the tabulated report of the results of the boiler trials.

The management of the engine during the trial was under the direction of the contractors exclusively. Two indicators were placed on the high pressure cylinders and two on the low, and indicator cards from both steam cylinders were taken simultaneously at intervals during the 24 hours. One of these cards has been enlarged and plotted to scale, and from it has been determined the quantity of steam used per hour, quantity of steam per horse power per hour, together with the volume of steam admitted to cylinders. The isothermal curve and the adiabatic curve are both traced on the diagram, and the area of the actual card in per cent. of the theoretical is given.

The specifications, section 12, make it optional with the Chief Engineer of the Bureau of Water whether the capacity shall be determined by weir measurement or by plunger displacement. There being no pumping main or weir available for that method of measurement, by your direction the capacity was determined by plunger displacement, and the duty and the capacity test were run at the same time. By partially closing an outside stop valve the water gauge was made to indicate the required pressure, including static and frictional head.

CALCULATED DATA.

Volume of high pressure cylinder including clearance in cubic feet	24.128
Volume of low pressure cylinder including clearance in cubic feet	96.80
Total cubic feet in both cylinders including clearance, cubic feet	120.93
Ratio of volume of low pressure cylinder to volume of high pressure cylinder	4.01
Cubic feet in one volume calculated from indicator card	7.56
Ratio of expansion by pressure	12.44
Ration of expansion by volumes	12.80
Area of theoretical card, sq. ins	65.45
Area of actual card, sq. ins	53.16
Area of actual in per cent. of theoretical	81.22
Indicated horse power	772.7
Pounds of steam per stroke	1.95
Pounds of steam per hour by card, including jacket	9,548.1
Pounds of steam per indicated horse power per hour by card, including jacket	12.36
Pounds of steam per indicated horse power per hour, from water actually weighed into boilers	14.94
Per cent. of water accounted for by indicator card and jacket water	82.
Total amount of jacket water by actual weight during the 24 hours	26,276.
Jacket water per hour	1,095.

Eleven calorimetrical observations on the quality of steam were made during the test at intervals of about two hours each.

Weight of water heated, pounds	200.
Weight of steam condensed, pounds	10.06
Initial temperature, deg. F	57.39
Final temperature, deg. F	111.14
Elevation of heat of water by condensation of steam, deg. F	53.75
Absolute steam pressure, pounds	111.35
Latent heat units at observed pressure	878.95
Latent heat units of steam as found	848.974 F
Quality of steam	0.965
Percentage of water contained in steam	3.5

AVERAGES OF OBSERVED DATA.

Averages of the observed data during the 24 hours—complete table of which it is not necessary to give—are as follows:

Steam Pressures.

Nov. 29th, 8 A. M.: Boilers Nos.		34	35	36	37	38
Pres. by gauge,		98	98	98	98	98
Nov. 30th, 8 A. M.:						
Pres. by guage,		97	97	97	97	97
Ave. for 24 hours, 49 readings,	96, 53, 96, 53, 96, 53, 96, 53, 96, 53.					

WATER GAUGES—BOILERS.

Levels in ins. of water in glass tube, 8 A. M., Nov. 29th:

Boilers Nos.	34	35	36	37	38
Levels, ins.,	8	7⅞	8⅛	8	7¼ = 39¼

Levels in ins. of water in glass tube, 8 A. M., Nov. 30th:

Boilers Nos.	34	35	36	37	38
Levels, ins.,	7⅝	7½	8¼	8	7¾ = 39

TEMPERATURE OF FEED WATER.

The temperature of the feed water in the large tank was taken three times during each hour, but the distance from the feed pumps to the boilers was so great that a thermometer was placed in the feed pipe near the boilers, from which the temperature of the feed water entering boilers was taken.

	Nov. 29th, 8 A. M.	Nov. 30th, 8. A. M.	Average of 49 readings.
In tank	87	97	98.2
In pipe before entering boilers.	86	96	96.3

TEMPERATURE OF ESCAPING GASES.

Pyrometer Readings.

Nov. 29th, 8. A. M.	Nov. 30th, 8 A. M.	Average of 49 readings.
612° F.	650° F.	555° F.

TEMPERATURE.

Fire room, 8 A. M., November 29th	68° F.
Fire room, 8 A. M., November 30th	67° F.
Fire room, average of 49 readings	66° F.
Outside air, 8 A. M., November 29th	36° F.
Outside air, 8 A. M., November 30th	26° F.
Outside air, average of 49 readings	35° F.
Mean barometer readings, 24 hours, from Signal Service Bureau	30.55
Mean pressure, pounds	15.05

ANEMOMETER READINGS.

Velocity of air passing through fire grate per minute; Average of 4 readings:

Boiler 34	235 ft.
Boiler 35	237 ft.
Boiler 36	220 ft.
Boiler 37	260 ft.
Boiler 38	225 ft.

Average of 20 readings: 235 ft.

COAL TO BOILERS.

Total pounds of coal weighed	44,014
Less 6 per cent. for moisture	2,641
Dry coal, pounds	41,373
Less 24.38 per cent. of waste	10,088
Total combustible, pounds	31,285
Evaporation of boilers per pound of combustible from and at 212° F., pounds	10.35

The following order was observed in cleaning fires:

Boilers 34 and 36, furnaces Nos. 1 and 2: Time, 5 A. M., 12 Noon, 5 P. M., 12 M., 5 A. M.

Boilers 34 and 37, furnaces Nos. 2 and 1: Time, 5.30 A. M., 12.30 P. M., 5.30 P. M., 12.30 A. M., 5.30 A. M.

Boilers 35 and 37, furnaces Nos. 1 and 2: Time, 6 A. M., 1 P. M., 6 P. M., 1 A. M., 6 A. M.

Boilers 35 and 38, furnaces Nos. 2 and 1: Time, 6.30, A. M., 1.30 P. M., 6.30 P. M., 1.30. A. M., 5.30 A. M.

Boilers 36 and 38, furnaces Nos. 1 and 2: Time, 7 A. M., 2 P. M., 7 P. M., 2 A. M., 7 A. M.

Ash clinker and unburnt coal were weighed back as follows:

November 29th, 2.15 P. M., pounds	2,850
November 29th, 7.10 P. M., pounds	2,2?5
November 30th, 2.15 A. M., pounds	3,139
November 30th, 7.15 A. M., pounds	1,834
Total pounds	10,088

Percentage of non-combustible:

$$\frac{10{,}088 \times 100}{41{,}373.16} = 24.38$$

The records in the engine room consisted of readings from the engine counter; steam gauge on steam pipe; water pressure gauge connected with the pumping main, and the vacuum gauge every half hour, with the following initial and final readings and averages:

Readings at 8 A. M. Nov. 29:

Steam Gauge.	Water Gauge.	Vacuum.
96.	71.5	27.

Readings at 8 A. M. Nov 30:

Steam Gau e.	Water Gauge.	Vacuum.
95.	73.5	27.5

Average readings for 24 hours:

Steam Gauge, 49 readings,	Water Gauge, 49 readings,	Vacuum, 49 readings.
95.3	70.99	27.5

RESULTS FOR CAPACITY.

Counter on engine 8 A. M., Nov. 29th	719,0 1
Counter on engine 8 A. M., Nov. 30th	745,011
Revolutions of engine in 24 hours	26,010
Revolutions per hour	1,083.7
Revolutions per minute	18.063
Number of strokes in 24 hours	104,040
Diameter of plungers, feet	3.00
Stroke of plungers, feet	4.10

From data obtained on previous tests of the same arrangement of pump valves and plungers, it was agreed to allow 2 per cent. for slip or loss of action due to supposed imperfect filling of the pump chambers.

Area of 3 feet, diameter of plunger	7.0686 sq. ft.
Less ¾ area of 6 inch, diameter of plunger rod	.0981 " "
	6.9705 " "
Cubic feet per stroke 6.9705 × 4 =	27.882 cu. ft.
Number of strokes in 24 hours =	104,040
Number of cubic feet in 24 hours = 104,040 × 27.882 = 2,900,843.28	
Number of gallons in 24 hours = 2,900,843.28 × 7.48 = 21,698,307.7	
Less 2 per cent. for slip,	433,966.2
Total capacity,	21,264,341.5

During this time the engine made 18.063 revolutions per minute, or a piston speed of 144.5 feet per minute.

The contractors' guarantee was a delivery of 20,000,000 gallons, with a piston speed of 140 ft. per minute, or 17½ revolutions per minute. The capacity at the contractors' guarantee is as follows:

Number of strokes in 24 hours,	100,800.
Cubic feet per stroke,	27.882
Gallons per cubic foot,	7.48
Number of gallons in 24 hours = 27.882 × 7.48 × 100,800 = 21,022,848.	
Less 2 per cent. for slip,	420,456.
Total capacity,	20,602,392.

which is about 3 per cent. in *excess* of guarantee.

Capacity during test,	21,264,341

which is over 6 per cent. above the guarantee.

RESULTS FOR DUTY.

Engine counter at 8 A. M. Nov. 29th	719,001.
Engine counter at 8 A. M., Nov. 30th	745,011.
Revolutions in 24 hours	26,010.
Revolutions per hour	1,083.7
Revolutions per minute	18,063
Piston speed per minute during 24 hours, ft.	144.5
Mean head by water pressure gauge, 49 readings, pounds	70.99
Mean head by water pressure gauge feet	163.937
Mean distance from center of water pressure gauge to level of water in forebay feet	25.00
Contract allowance for friction of water passages in pumps	2.3093
Total head in feet, as per printed specifications, *H*	191 246
Temperature of water in forebay	49 F.
Weight of 1 cu. ft. of water at that temperature	62.41
Cubic feet of water displaced at one stroke of plunger	27.882
Pounds of water at one stroke, *P*	1,740.116
Number of strokes in 24 hours, *N*	104,040.
Total weight of water weighed to boilers	286,982.
Less 3¼ per cent. for entrained water in steam	10,044.4
W	276,937.6

Then $D = \frac{1740.116 \times 104{,}040 \times 191.246 \times 100}{27{,}693.76}$

= 125,022,730 ft. lbs. per 100 lbs. of coal, or 15,022,730 in excess of guarantee; or nearly 14 per cent.

The contractors claim that the 2 per cent. for slip shall not be deducted from the duty obtained from the reading of the pressure gauge, for the reason that the pressure by gauge remains constant, and this difference, if any, is caused by the plunger forcing the water under the valves, and the work done by the pumps should be calculated from the pressure as given by the water gauge.

Deducting this 2 per cent. for slip, the duty becomes 122,522,276 ft. lbs. per 100 lbs. of coal, or 12,522,376 ft. lbs. in excess of guarantees—or nearly 12 per cent.

Connecting the Mississippi and the Upper Lakes.

The address of Maj. THOMAS H. HANDBURY, U. S. Eng'rs., before the Illinois River Improvement Convention of Oct. 11, 1887, has been published in full, and it contains so much interesting data on this projected public work, that we make the following abstract:—

A map of this section of our country shows a chain of inland seas with their outlet to the Atlantic Ocean flowing through a foreign country; while but a short distance removed from the greatest of these seas, but not now connected with them, is the broad Mississippi river emptying into the Gulf of Mexico. Near the head waters of one of the tributaries of the Mississippi, the Illinois river, is a divide between the water flowing into this tributary and those flowing into lake Michigan, the summit of which is only 10 ft. above the mean level of the lake, which latter is 581 ft. above sea-level.

A study of the geology of this region shows that in a recent geological period the waters of the upper lakes flowed as a wide and deep river through this Illinois river valley on to the Gulf of Mexico. And the effort is now being made to restore this ancient waterway for the benefit of the internal commerce and purposes of public policy.

In the early part of this century, GALLATIN, DE WITT CLINTON, GOUVERNEUR MORRIS, these pioneers of our internal transportion, laid out a possible path for commerce which starting at New York, passed to Albany, thence along the present Erie Canal to Buffalo, through the lakes to Lake Michigan and across this very divide to the Illinois river, Mississippi river and the Gulf of Mexico. This was a grand scheme only, as yet, partially realized in all possibilities. Soon after Illinois became a State (about 1822) efforts were made to build a canal between Lake Michigan and the Illinois river; and this canal was actually commenced in 1836 and finished in 1848, and is in operation to-day. It is 97.27 miles in length from Chicago to La Salle, the present head of navigation on the Illinois river. In this distance it falls 142 ft., with locks 110×18 ft. with 6 ft. of water over the miter-sills. It is open to boats drawing 4 ft. 8-ins. for the entire length of the canal. It is now a local convenience only, of little service to general commerce.

The inadequacy of this canal was soon recognized, and in 1852 the U. S. Government made its first direct appropriation, of $30,000, for the improvement of the Illinois river. Up to 1880 all the public money expended upon it was utilized in removing snags, making wing-dams, dredging sand-bars, etc.

The first steps looking towards the present project were taken in 1866, when an Act of Congress, of June 23, authorized a survey of the Illinois river from its mouth to La Salle. This preliminary survey was made under the direction of Gen. J. H. WILSON, then Colonel of the 35th Infantry, U. S. A., but formerly an officer of the Engineer Corps. He recommended a more detailed investigation and survey of the whole route; and his work developed beyond a doubt the possibilities of this route as a great waterway adapted to the commercial and military necessities of the country.

In 1867, Gen. WILSON and WM. GOODING, the latter for 30 years Chief Engineer of the Illinois and Michigan Canal, were appointed as a Board of Engineers "to conduct surveys and examinations, and prepare plans and estimates for a system of navigation by way of the Illinois river, between the Mississippi and Lake Michigan, adapted to military, naval and commercial purposes, in accordance with the Act of March 2, 1867." These gentlemen finally recommended a canal not less than 160 ft. wide, with a navigable depth of 6 ft. (corresponding to the lowest known level of Lake Michigan), with locks 356 ft. long between gates, 75 ft. wide and 7 ft. deep. The slack water navigation of the river was to be improved to 7 ft. at the lowest stage. The distance from Chicago to the mouth of the Illinois river, by the route selected, was 322 miles, and the estimated

cost of the improvement was $18,218,240. The amount of lockage to the Mississippi river was 170 ft., all descending towards that river.

This Board in its report discussed two other methods of improving the river from La Salle to its mouth, proposed by some of the best engineers in the country. These were—(1) By dredging and wing dams. (2) By drawing a sufficient supply of water from Lake Michigan to give the requisite depth in the Illinois river. The first plan was followed by the Government for some years after the report; and the result showed that no amount expended on that plan would give the depth of water required for "military, naval and commercial purposes."

With regard to the second plan, the Board assumed that in addition to the low water discharge, 4,555 cu. ft. of water per second would be required to give a channel 8 ft. deep and 160 ft. wide. To obtain this additional amount of water would cost $20,000,000 more than the improvement recommend. This figure is about the amount estimated by the Chicago Drainage Commission to be necessary for bringing the sewage of the city from South Fork to Joliet. In connection with this drawing of a large supply of water from Lake Michigan, a very important point to be considered, and one not yet discussed in any of the reports, is the effect of the withdrawal of so large a quantity of water from Lake Michigan, as is proposed by the Chicago Drainage Commission, upon the mean level of the lake.

The discharge of the upper lakes through the St. Clair river has been found to be about 217,000 cu. ft. per second. The mean level of Lake Huron and Michigan is 581 ft. above the sea, and that of Lake Superior is 20 ft. higher. The lower lakes receive their supply from the upper lake and the various streams that empty into them; and the discharge is just equal to the supply and the lakes remain at their mean level of 581 ft. If we now make another outlet in this lower reservoir, capable of taking off one-twentieth of this supply, what is going to happen in time to the mean level of the lake, and to the depth of water in the various harbors and the channel of the St. Clair river, upon which the Government is now spending much money? This is a question upon which the people at the other outlet to the lake may wish to have something to say. But it is of such a purely engineering nature that it can be safely left to any competent board of engineers to decide.

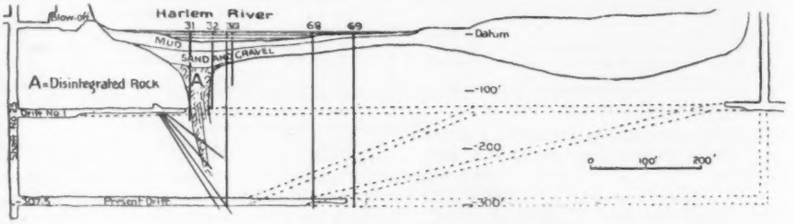
The address then briefly describes the three other routes suggested from the lakes to the Mississippi. The route by way of the Fox and Wisconsin rivers contemplates a low-water channel, 100 ft. wide and 6 ft. deep; with locks and dams on the Fox river and wing-dams for scour on the Wisconsin. The distance from Prairie du Chien, on the Mississippi at the mouth of the Wisconsin, to the mouth of the Fox river, at Green bay, is 265 miles. The lockage amounts to 387 ft. with a summit level 208 ft. above Lake Michigan.

The route by way of the Rock, Illinois and Wisconsin rivers was surveyed in 1866. The survey commenced at Fond du Lac, Wisconsin, and ended at Rock Island, Illinois. The plan contemplated slack water navigation along the Rock river, 167½ miles (the remaining 117½ is provided with an independent canal and lock) then from Fond du Lac to Green bay along the line of Lake Winnebago and the Lower Fox river. The minimum width of canal was to be 85 ft.; depth 7 ft. throughout; locks, 200 ft. by 30 ft.; total length improved, 285 miles; estimated cost of improvement, $14,738,370. The lockage amounted to 618 ft. with a summit 285 ft. above Lake Michigan. This project is not yet sanctioned by any appropriation for its commencement.

The so called Hennepin canal route contemplates a canal 80 ft. wide, 7 ft. deep, with locks 170 ft. by 30 ft., from the town of Hennepin, on the Illinois river, to the Mississippi river at or above Rock Island. The Illinois and Michigan canal is to be enlarged throughout its entire length to correspond to these dimensions. The lockage by this route is, by the Rock Island line, 306 ft.; by the Watertown line, 295 ft., and by the Marais d'Osier line, 280 ft. From the lake to the Illinois river at Hennepin the fall is 149 ft.; from this point to the summit common to all the lines the rise is 205 ft. The summit level would be fed by a feeder of like dimensions with the main canal leading out of the Rock river at Dixon, 37 miles off.

To return now to the Illinois river; Congress taking no definite action on the recommendations of the WILSON board, of State of Illinois, in Feb. 1869, ordered the construction of a lock and dam at Henry, thus forming the first link in the present chain of the river improvements. This work was carried out by the State Board of Canal Commissioners substantially on the plans of the WILSON board. In 1873, Col. MACOMB, then in charge of the Government work on the Illinois river, recommended that the United States construct the foundation of the Copperas Creek lock. This recommendation was approved by the Secretary of War, and the work was finished in 1874 at a cost of $62,359.80.

In the river and harbor bill of 1880 was an item of $110,000 for the improvement of the Illinois river, "of which sum $100,000 was to be expended on locks and dams and $10,000 for dredging." This was the first authoritative approval by Congress of the project for improving the Illinois river between Copperas creek and its mouth. At the present time all the money appropriated by Congress has been expended substantially in the construction of two locks, one at La Grange, 70 miles, and the other at Kampville, 30 miles, above the mouth of the river.



Harlem River Tunnel; New Croton Aqueduct.

The remainder of this address is devoted to the discussion of the commercial and military bearing of the proposed improvement. In this latter connection it is assumed that the contemplated waterway must not be confined to 7 ft. in depth. This would limit the draft of vessels using it to that of the low-water stage of the river. The division from the lake to Joliet should be made 10, 12 or 14 ft. deep, as found necessary to meet the exigencies of traffic during the higher stages of water in the river. The quantity of water necessary for the purposes of navigation which must be drawn from the lake can be ascertained and regulated by the slope of the upper reach of this section.

The Harlem River Tunnel.

In bringing the water of the Croton river to New York by the New Croton Aqueduct the crossing of the Harlem river is made by a tunnel instead of an arched structure similar to the High Bridge. The reasons for this radical change from the design of the original Croton Aqueduct are apparent in a greater security from accidental rupture and malicious mischief, considered in connection with the great calamity that might attend any interference with the public water supply of the present New York.

Careful preliminary borings with a diamond drill on either shore at first indicated that sound rock was to be found at a point 150 ft. below the surface of the river. Shaft No. 25 was accordingly sunk to this point and a test heading (marked Drift No. 1 on the profile) was driven under the river for a distance of about 300 ft. At this point the character of the rock changed to a disintegrated and decomposed gneiss rock (marked *A*) which admitted considerable water into the heading and gave bad promise for the location of a tunnel which was to be submitted to a very heavy hydrostatic pressure. A halt was called at this point, and the ground ahead and beneath the drift was further investigated by test-holes made with the diamond drill, and in the direction and to the depths indicated by the heavy black lines on the profile, including the vertical holes from the surface of the river and one on the line of the drift omitted in our sketch.

The result of these borings showed a deep fissure under the bed of the Harlem river filled with this decomposed rock, but limited in its horizontal width and practically disappearing at a point about 250 ft. below the river surface. Beyond and beneath this fissure sound gneiss rock was indicated, interstratified with thin quartz seams and white limestone.

To remove all question of doubt in the security of the tunnel under pressure and to avoid the necessity of lining the tunnel with metal, as originally contemplated, shaft No. 25 was sunk to the level of 307.5, about twice the original depth. Work on the new drift has now been pushed to the point indicated on the profile, and the rock penetrated has been hard and almost absolutely dry. The troublesome fissure has been passed, and the only point to be next considered was the connection of this lower drift with shaft No. 24, on the east bank of the Harlem river.

Motives of economy at first suggested a connection on one of the two dotted ascending drifts. But when the danger of again meeting bad rock in this direction, and the troublesome nature of the working of an inclined drift were considered, the engineers wisely recommended the continuation of the lower drift on its present direction and the sinking of shaft 24 to meet it. The Commission lately approved of this latter plan, and it is being carried out. It will cost more money if all things are equal; but the avoidance of a possible danger in meeting bad rock on a higher level is worth paying for; and any repetition of the experience on the west bank would very soon wipe out any margin of difference in the two schemes. The dip in the rock contour on the east shore of the river bears a suspicious resemblance to the one that has already caused trouble, and it is possible that a high level tunnel might find another fissure that had better be more economically passed on the present line. An inspection of the profile, which is drawn to natural scale, will show that the general indications in the two pockets are very much alike, as far as possible trouble is concerned.

The Effect of Temperature on the Strength of Railway Axles.

(With Inset.)

In connection with the paper by Mr. Jos. RAMSEY, published in our issue of Dec. 3, 1887, and subsequent issues, with the discussion thereon, it has appeared to us particularly desirable to give the results of a very careful and valuable investigation made by Mr. THOS. ANDREWS, Assoc. M. Inst. C. E. and published in the Transactions of the Institution about a year ago, as to the effect of heat and cold on the strength of railway axles. We had intended abstracting this paper at the time it appeared, in fact, but it happened to be laid over. It has for some reason not attracted the attention it deserves, being, as it is one of the most careful and complete investigations of that subject ever made, and probably most of our readers will hear of it for the first time. We are not prepared to say that the indications of the paper can be accepted as decisive. This in fact is expressly disclaimed in the paper, but it is certainly very strong evidence. The more important features of the paper were as follows:

The author has been engaged 23 years in the manufacture, examination and testing of railway axles, etc., at the Wortley Ironworks, near Sheffield, which have been in the occupation of his family for two generations, and were in operation previous to the year A. D. 1660. The object of the research was to investigate the effects of varying temperature on the resistance to impact of railway axles. It has been already shown by careful experiment "that the absolute or tensile strength of iron and steel is not diminished by cold,"* and this under certain conditions may, pending evidence to the contrary, be accepted as an established fact, so far as relates only to the resistance to tensile-strain or steadily applied

* "Iron and Steel." By Knut Styffe, p. 111.

pressure. Transverse sudden impact under similar conditions of low temperature appears to produce a different effect, which has hitherto received only a limited experimental attention, at least on the full-sized scale, possibly owing to the difficulty and considerable cost of such experiments—the problem requiring solution was therefore involved in some obscurity. The serious Newark accident in 1869, from the breaking of a steel tire during severe frost, directed public attention to the subject. Shortly afterwards, the eminent physicist, Dr. JOULE, made a series of experiments "On the alleged action of cold in rendering iron and steel brittle," and inferred therefrom that "Frost does not make either iron (cast or wrought) or steel brittle;" and Mr. PETER SPENCER arrived at a similar conclusion in his experiments.[1]

About the same time Mr. BROCKBANK also recorded the result of his investigations in the same direction, which led him to a decision the reverse of Dr. JOULE'S.[2] Observations on the influence of temperature on the tensile-strength of metals were previously made by the late Sir W. FAIRBAIRN, and also by Mr KIRKALDY. Some recent interesting experiments are recorded in a Paper by Engineer-in-Chief E. CORNUT, of the North of France Association (read on the 10 and 12 of September, 1882, before the "Association des Propriétaires d'Appareils a vapeur," Bordeaux, France).

Other authorities on the resistance of metals at high temperatures are Mr. WARLAND,[3] Mr. CHARLES HUSTON,[4] Mr. GREINER,[5] Mr. KOLLMANN and Mr. C. R. ROELKER.[6]

The above observations, however, relate chiefly to the influence of temperature on the tensile endurance, etc., under steady pressures. The author would also refer to the experiments on rails by Mr. C. P. SANDBERG, and to the observations of J. J. WEBSTER, which relate to the effect of temperature on the resistance of metals to impact,[7] though it is to be regretted that this portion of the latter gentlemen's experiments were, in the case of wrought-iron, limited to twelve bars of common iron, only ⅞-in. sq.; they afforded nevertheless a valuable indication. Mr. KNUT STYFFE does not appear to have touched experimentally on the impact (transversely applied) aspect of the question, although he has expressed some views thereon.

Valuable and interesting as these previous experiments have been, the author thought that more extensive and elaborate observations on the full-sized scale were required; as it may be surmised that the behavior of large forgings such as railway axles would vary somewhat from that of rails and smaller rolled bars, the influence of size, form, and manipulation would affect results. It could not be expected that experiments made with small rolled bars should approximate so nearly to the truth as those made on full-sized railway forgings, manipulated in every way, both as regards quality of material, workmanship, and form, precisely as those actually running.

Referring again to Mr. WEBSTER'S Paper, both in that memoir and also during the discussion following, much practical testimony was adduced relating to the destructive effects on iron and steel noticed generally during prevalence of low temperatures. There appeared, moreover, a consensus of opinion, supported by many quoted facts, that in practice many more breakages occurred in railway iron and steel during seasons of cold than in summer heat; especially so in countries where the cold of winter is either extreme or liable to rapid variation, as in some parts of Russia, where the winter temperature not unfrequently varies from 0° to —40° Centigrade; and in Norway, where it is sometimes as low as from —20° to —40° Fahrenheit; and North America, —30° or —40° Fahrenheit.

[Some meteorological data as to the Canadian climate, which is pretty well understood in this country, are then given, and the paper continues:]

The extract below from a letter by Mr. WALLIS, Mechanical Supt. Grand Trunk Railway, of Canada, to Mr. G. REAVES, expresses his experience of the effect of temperature in that country on axles, etc.: "I may say, for Mr. ANDREWS' information, that although it is difficult to arrive at actual relative facts, under so many different conditions of working, as to load, iron, and manufacture of axle, etc., etc., there is no doubt that the breakage, both of axles and tires (all other conditions except that of temperature being equal), is greatly influenced by the severity of the climate in winter."

A more immediate object of the author's research was to endeavor to determine the comparative effect of temperatures, within a moderate range of actual experience, on the resistance and strength of railway axles exposed to sudden impact. The rough method of testing by the sudden impact of a heavy weight falling some distance was adopted, as more likely to approximate to the sudden and heavy shocks of practical railway work, and the distance the testing ball was allowed to fall was selected, after careful consideration, as generally suitable for the purposes of this inquiry, though perhaps a less drop might have been preferable in some respects as affording a test of more even character. The hardening and solidification of the whole of the permnent way during the prevalence of low temperatures has been assumed by Dr. JOULE, Mr. STYFFE, and others, to be, if not the sole, probably the chief cause of liability to breakage on railways in frosty weather. STYFFE has demonstrated that, under certain conditions of low temperature, the resistance of the timber of the permanent-way is increased by about 12 per cent.[1]

The tests generally were of an extensive and severe character, requiring the greatest care, and they occupied a very considerable time in completion. Forty-two complete railway-axles were tested and used in the course of the research; and above 61 tons of snow, ice, and salt, were consumed. The wrought iron forgings employed were full-sized Best Best faggoted scrap railway-carriage axles, made primarily from clean selected scrap iron, worked and afterwards forged into axles by methods in vogue at the Wortley Ironworks about 50 years. The brand of the axles was that generally known as "Wortley Best Best."

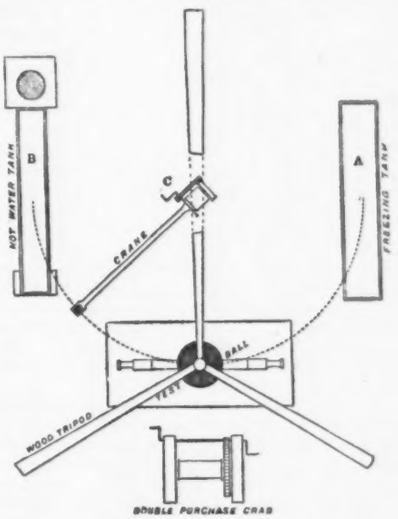
in. wheel-fit, and 4¼ in. center diameter). The weight of each axle was 425 lbs.

The greatest care was exercised in endeavoring to preserve practical uniformity during manipulation. The chemical analysis of the finished forgings was as in Table II.

METHOD OF EXPERIMENTATION.

The apparatus for testing was constructed as follows. The two grooved supports on which the axle was laid (to receive the impact of the weight allowed to fall on its center) were heavy metal castings, let in and firmly secured to a heart of oak bed-plate 7 ft. 10 in. long, 3 ft. 7 ins. wide, 12 ins. thick, resting on a suitably firm ashlar foundation, which in turn reposed at a convenient depth from the surface, on solid ground. Railway axles have been regularly tested on this spot for many years.

Adjacent to the testing apparatus was placed a large wooden tank *A* used for immersing the axles



Plan of Testing Plant.

Table I.—Tensile-strain Test of a Best Best Scrap Railway-Carriage Axle turned down to 2¼ ins. diameter, and a portion from another axle turned down to 1¾ in.

Original.		Ultimate Stress.		Ratio of Elastic to Ultimate.	Contraction of Area at fracture.	Extension.		Appearance of Fracture.
Diameter	Area.	Elastic per sq. in.	Ultimate per sq. in.			At 40,000 lbs. per sq. in.	Ultimate.	
Inch.	Sq. in.	lbs.	lbs.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
2·257	4·000	23,800	48,372 (21·59 tons.)	49·2	25·3	4·79	19·7	{ 80, fibrous. { 20, crystalline
1·597	2·000	28,200	48,790 (21·78 tons.)	57·7	26·3	3·53	17·9	100, fibrous.

The axle-tests were arranged into Sets I, II, and III. The axles used in Set I and Set II were made from rather smaller scrap than those employed in Set III, but were otherwise worked under equal conditions. The fractures of the axles in Sets I and II appeared consequently to manifest generally a rather finer grain. These forgings afforded for the research a fair representative selection from a class of best best scrap iron railway axles usually employed in practice for railway carriages. To insure as near as practicable a uniform molecular structure, quality and standard of workmanship, the whole of the forgings were submitted to similar treatment; and the same furnaces, machinery and hammers were employed throughout. The forgings were made to a well known railway specification to which

Table II.—Chemical Analysis of the Axles.

Description.	Combined Carbon (by color test.)	Silicon.	Sulphur.	Phosphorous.	Manganese.	Iron (by difference.)	Total.
Sets I & II	0·068	0.158	0.007	0·108	0·360	99·299	100·000
Set III	0·038	0·117	0·09	0·246	0.112	99.468	100·000

the author has supplied many thousands of axles, and when finished they were each exactly of the same dimensions (7 ft. 3 in. long, 3⅝ in. journal, 5⅛

in the freezing mixture, pierced with small holes at the bottom for the water to escape. A cast metal water-tank *B*, attached to which was a stove with damper, chimney, etc., was employed in the capacity of a water-bath for obtaining the higher temperatures.

The jib-crane *C*, with appropriate tackle, was erected in a convenient situation between the hot and the cold tanks for rapidly removing the axle from either tank to the testing-apparatus. A double purchase crab with three sheaved blocks, worked in connection with a tall, strong wooden tripod 30 ft. high, was used for raising the testing ball to any needed elevation. The falling weight was of tough cast metal weighing exactly 1 ton; it was somewhat pear-shaped and rounded at the bottom. It was arranged to fall from any height (measured by accurate gauges) by means of an easily worked catch hook attached. A ground plan showing the general arrangement is given by the cut.

The experiments were arranged into cold and into warm tests in the following sets.

Set I.—Tested at a temperature of 212° Fahr. compared under equal conditions otherwise with the behavior of axles of the same size and manufacture, but at the low temperatures of 7° to 10° Fahr. These tests should manifest some approximation to the conduct of axles under impact, which may have become abnormally heated from accidental causes near the journals.

Set II.—Temperature of 120° Fahr. compared

[1] "The Chemical News." Vol. xxiii. pp. 101, 109 and 124.
[2] *Ibid.* p. 62.
[3] "Annales Industrielles," 1882, vol. I. p. 748.
[4] "Annales des Mines," 1878.
[5] Bulletin de l' Association des Ingénieurs sortis de l'école de Liége. 6 Mai. 1881.
[6] Journal of the Franklin Institute. Vol. cxii. 1881, p. 241.
[7] Minutes of Proceedings Inst. C. E. vol. lx. p. 161.
[1] "Iron and Steel." By Knut Styffe, p. 113.

under equal conditions otherwise with similar axles tested at the lower temperatures of 7° to 10°.

Set III.—Temperature of 100° Fahr. compared under the same conditions otherwise with axles at 7° to 10°. This temperature was selected as affording an approach to the occasional summer heat of temperate countries, and to the atmospheric conditions in the shade of the Indian and similar climates.

The experiments were purposely made, not at extreme temperatures but within ordinary working extremes of the English and European climate, which are very far within the extremes of our Amerian climate at each end.

The freezing mixture was 2 parts by weight of snow and ice to 1 salt, in sufficient volume to immerse several axles.

This was placed in track *A*, Fig. 1, and gave a constant temperature of — 4°. The atmospheric temperature was also continuously taken. Test axles purely for temperature were placed in the mixture, by which it was known that the axles were homogeneously cooled or warmed throughout, so that no internal temperature strains can have existed in any case. Their "temperature of normal rigidity," which apparently means the temperature of the air when they were manufactured is given for each axle and is stated to have been "comparatively low, as they were manufactured in winter, and about midway between the low and high temperatures of testing." The meaning of the term "normal rigidity" is more fully explained below.

It would seem, however, that the strength of some of the axles, tested in the cold, was materially affected by the first sudden chill on immersion in the freezing mixture, some of them appearing to have been more influenced in this respect than others, though the conditions were practically identical.

To reduce an axle to 0° Fah. immersion in the tank for fully 2¾ hours was necessary, and although left therein for 17 hours, a regular series of observations of the internal temperature of the axle showed that it remained at 0° Fahr. exactly, although the thermometer registered — 4° Fahr. as the constant temperature of the freezing mixture in which the axle was immersed.

An experiment was also made to illustrate the relative rate of cooling between the surface and the center of an axle under the conditions stated on Table I, and affords an indication of the mode in which railway axles adapt themselves internally to temperature changes. Two holes, ⅝-in. diameter, were longitudinally drilled, one in the center of an axle forging, and the other close to the outside. Into these two standard thermometers were placed, the upper stems of which were protected by iron pipes closed at the top with corks; the whole was immersed upright in the center of an iron tank *B*, and completely covered and surrounded with a freezing mixture. The temperature of the freezing mixture was also taken by another thermometer. The thermometers were simultaneously withdrawn, and the results given on Table I, indicate the difference between the internal and external temperature of the axle, and show the time required for thermal uniformity to obtain throughout the forging.

TABLE I.—ATMOSPHERIC TEMPERATURE DURING THE EXPERIMENT. 44°.

Time from Commencement of Experiment.	Temperature of Freezing Mixture.	Temperature near Outside of Axle.	Temperature in Center of Axle.
	° F.	° F.	° F.
Commencement	.....	45	48
1 Minute.	.....	42	45
6 Minutes.	.....	34	37
11 "	0	30	34
16 "	—4	26	28
21 "	—4	24	27
26 "	—4	22	25
31 "	—4	21	22
36 "	—4	20	20
41 "	—4	18	19
46 "	—4	18	18
51 "	—4	18	18

These observations on the internal and external temperature of the axle were taken at frequent intervals for 27 hours. The axle reached a temperature of 0° Fahr. in 2 h., 40 min. from first immersion; but no difference was noticed between the internal and external temperature of the forging beyond 51 minutes from commencement, the rate of cooling being thenceforward uniform throughout the metal. The observations, however, were prolonged to investigate the matter fully.

The temperature of the test-axles did not reach 0° Fahr., owing to their periodic removal from the freezing mixture to and from the testing apparatus, and consequent regular frequent exposure to the warmer atmosphere in the same manner as during the periods of testings.

At the commencement of each test the axle under examination was allowed to remain in the tank for one hour, the internal temperature of the axle at the various periods of impact given in all the Tables was known from the record of the thermometer in the center of the other similar testing-axle placed in the same tank. The temperature testing-axle was removed from the tank, and reimmersed at the same time as the one undergoing the test of impact, so that an exact indication of the time-temperature might be obtained. At the expiration of the first hour each axle under examination was rapidly removed by the crane, and carefully adjusted on the supports, 3 ft. 6 in. apart, of the testing apparatus. The ball was allowed to fall on the center of the axle from the elevations recorded. The axle was then reimmersed in the freezing mixture for fifteen minutes, again withdrawn and placed on the testing apparatus, receiving another blow from the ball, but in a reverse direction from the first, as the axles in each case were half turned over after every blow. The object in view was to distort and disturb the fibre of the iron more effectually, so as more readily to approximate to heavy concussions and shocks occurring in actual practice. The author would here remark, that although in course of testing axles generally the method of reversing the position after each blow is in favor with some engineers, he is not disposed under all circumstances to endorse this method, which in some respects is open to objection.

The axle was then replaced in the tank for a further fifteen minutes, and the operation periodically repeated in the same manner until fracture occurred. The resultant permanent deflections were carefully measured after every blow.

The Warm Tests were conducted as follows:—The axle to be examined was placed in the warm-water bath B, in which a thermometer indicated the temperature required. The axle was allowed to remain therein for one hour,[1] and was then quickly removed by the crane, and duly adjusted on the testing apparatus, and received a blow from the falling weight. The axle was afterwards replaced in the warm-water bath for fifteen minutes, was again placed in position on the testing machine, being half turned round after each blow, as in the case of the cold tests, and the above operation was periodically repeated until fracture ensued, the results having been carefully noted.

Photographed Fractures.—As soon as an axle was broken, either during the cold testing or warm testing, the bright fracture was minutely examined, washed, and sponged with pure alcohol, and the end prepared for photographing with the least possible delay, which ensured the preservation of the exact appearance of each fracture under the conditions recorded.

It occurred to the author that as a point of fracture exhibits the lines of greatest weakness, a careful study, examination, and comparison of those fractures which had occurred under known conditions might probably reveal many features of interest, and perhaps tend to afford information regarding the molecular changes incident to breakage. The author was therefore very desirous to obtain the photographs as quickly as possible after the fracture, and regards them as an important part of his investigation. Considerable expedition was required to effect this, as it was not easy to preserve from rust and tarnish the actual fractures for any long period. A comparison of the photographs appear generally to show a more short or crystalline cleavage in the case of the cold tests; but a rather more fibrous character is manifested by the warm-test fractures, more so perhaps in Set III. The whole of the photographed fractures are not reproduced on the plates, but only a limited number of typical ones. (See Inset).

[1] A protected thermometer in the center of a warm test-axle used in the warm-water bath, recorded the periodical temperature of the axles for each blow.

The author has noticed that an increase in the extent of the first deflection at the first blow has an influence on the after endurance of an axle, and consequently he is of opinion that in testing axles by impact the application of a number of lesser impacts is preferable to the extremely heavy test-blows required in the specifications of some railway companies. Generally during the first blow the warm axles bent, on the average, about 14 per cent. more than the cold ones in Set III, when taken in their total length, and this increased flexion of the warm axles tended to some extent to affect their total endurance; but this inequality at the commencement was afterwards apparently counterbalanced, the peculiar and gradual reduction of deflection subsequent to the first or second blow in case of the warm tests appearing in itself generally sufficient to indnce comparatively nearly practical equality of flexion between the cold and the warm tests in each subsequent and consecutive blow up to the time of fracture. The relative difference in the extent of the deflection after the early commencement, in a series of 10 axles at 100° Fahr., and 10 axles at 7° Fahr. was only about 3 per cent. greater in the warm tests; and afterwards this difference even showed a slightly relative greater flexion in the cold tests when compared blow for blow.

Observations were also made with a view of ascertaining the heat imparted to the center of the axles by the force of impact; but it could not be conveniently estimated in these experiments, apparently owing to its rapid dispersion throughout the forging.

(TO BE CONTINUED).

Forty Thousand Lines to the Inch.

Dr. H. A. ROWLAND, of the Johns Hopkins University, has a new engine for ruling his plates for spectrum analysis or decomposition of light. This engine was made at the university under his supervision, and is the result of careful, painstaking effort. The most important part of it—the screw and its attachments for regulating the width of the lines—was carefully ground under water kept at a constant temperature, so as to avoid all error arising from expansion and contraction, and is guarded against so small an error as one-hundred thousandth of an inch. The engine is run by water power, and is inclosed in a glass case, and kept in a double-walled chamber in the basement, so as to provide as equable temperature as possible, so delicate is the machinery that while it is running the case is kept closed, as the heat from a person's body would affect it. The new machine at first was not satisfactory, but now the worst ruled plates by it are better than the best ruled by the old one. The old one hardly ruled more than 10,000 lines to the inch, while the new one has ruled as high as 40,000, and can be graduated to rule an almost infinite number, but the metal usually crumbles, and the lines run into each other above 20,000 to the inch. The plates are highly polished, and are made of what is known as speculum metal, though glass is sometimes used for experimental purposes. The prepared plate is placed on the machine, and the screw regulated to the required distance and when the machine starts it moves the plate the distance, say one-twenty-thousandth of an inch, and a small diamond point runs across and draws the line while the plate is stationary. It is a matter of infinite care, and several days are necessary for ruling a plate three or four inches in diameter. The diamond point can be so arranged as to vary every fiftieth or one-hundreth line, while at the end of the engine is a small counting machine for recording the number of lines drawn. In an adjoining room is a very costly instrument for measuring the width of the lines, and so marvelously accurate is it that an error of one-hundred-thousandth part of an inch, or even less, can be detected. The rulings of this machine are the finest in the world, and have been sent to different parts of the scholarly portion of it, one of the largest and best plates being presented to Prof. HELMHOLTZ, the world-famous physicist of Berlin. If a perfect machine means one that perfectly does the work it was designed for, this is probably the most perfect one in the world. *Baltimore Sun.*

The Sibley Bridge.

The Chicago, Santa Fé & Cal. R. R. bridge over the Missouri river at Sibley was practically opened on Jan. 29. The bridge is built of mild steel and iron with one 200 ft. deck span, three 400 ft. through spans and one 250 ft. and two 175 ft. deck spans. These rest on 8 masonry piers, and are connected on the north with 1,900 lin. ft. of iron viaduct approach, consisting of alternate 60 and 30 ft. spans on iron towers; beyond this is a wooden trestle 3,600 ft. long, making the total bridge length nearly 1½ miles. The piers are founded on 40 ft. piles cut off 20 ft. below the water surface, and on caissons sunk by compressed air. The caissons were of wood, 65 × 27 ft. and 17 ft. high; the sides 3 ft. and the roof, 8 ft. thick.

From the caissons 234,000 cu. ft. of material were removed, of which quantity 79,000 cu. ft. were bowlders and rock; 1,072,000 ft. B. M. of lumber were used in these caissons, and 128,000 lbs. iron bolts, rods, etc. The piers contained 8,529 cu. yds. of masonry and 5,798 cu. yds. of concrete; 10,000 barrels of cement were consumed. In the superstructure are 6,928,870 lbs. of iron and steel. The four river piers are 92½ ft. above low water in the clear, or 50 ft. above the flood stage of 1844.

The first work on the foundations was started in March, 1887; on April 8, the contractors started the caisson for pier 8. The erection of the superstructure was commenced on Aug. 1, 1887, and, as stated, the first train passed over the bridge on Jan. 29, 1888, 293 days after the commencement of work. The total cost of the bridge was $800,000.

The Chief Engineer was A. A. ROBINSON; Consulting Engineer, OCTAVE CHANUTE; Resident, JOHN F. WALLACE, and Assistant Engineers, OTTO T. SOUNE and GILBERT G. BELL. The substructure was built by the firm of SOOYSMITH & Co.; with GEORGE ADGATE as General Superintendent; the superstructure was manufactured by the Edgemoor Iron Works of Wilmington, Del., and was erected under General Superintendent JOHN KANE.

As showing the extreme rapidity of construction of this bridge the following interesting table has been prepared, giving the data and location of all previous bridges built across the Missouri, and proving that the Sibley bridge has surpassed all previous records:

Location.	First work done.	First engine crossed.	No. of days.
Kansas City	Feb. 27, 1867	June 25, 1869	847
St. Charles	Aug. 1, 1868	May 29, 1871	1032
Omaha	Feb. 3, 1869	April 15, 1872	1162
St. Joseph	Sept. 23, 1871	May 30, 1873	605
Plattsmouth	July 14, 1879	Dec. 28, 1880	532
Booneville	Oct. 1, 1874	March 15, 1874	502
Bismarck	Jan. 8, 1881	Oct. 21, 1882	620
Blair	June 12, 1882	Nov. 10, 1883	516
*Omaha	Sept. 1, 1885	Oct. 1, 1887	760
Randolph	Oct. 1, 1886	Oct. 15, 1887	379
Sibley	April 8, 1887	Jan. 25, 1888	293

*Rebuilding.

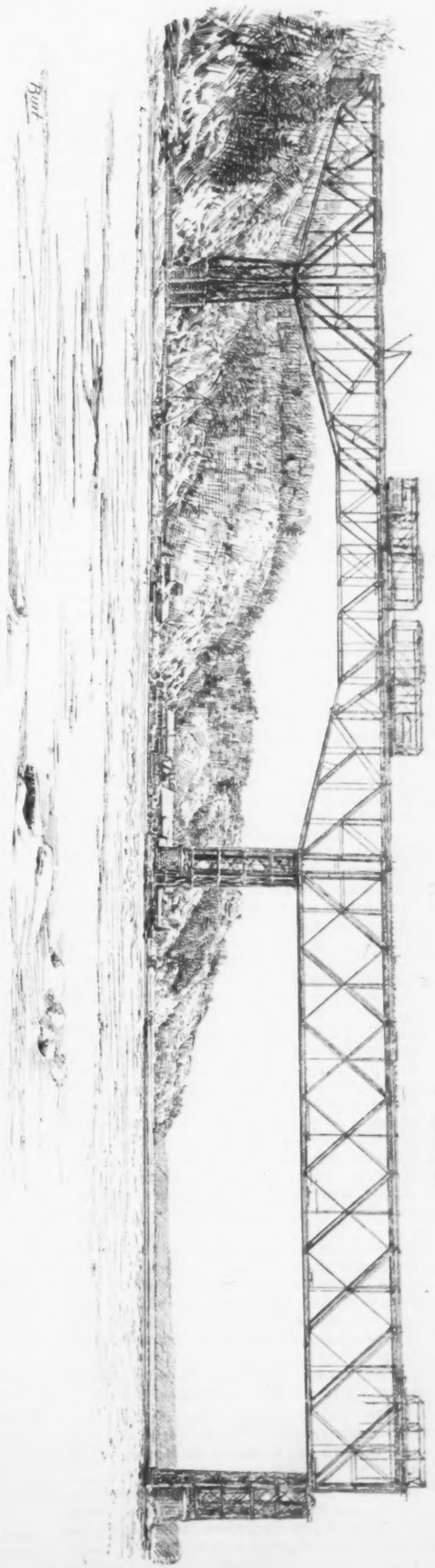
The record at Sibley is more remarkable still when we consider that five of the piers were founded by the pneumatic process under difficult conditions, including the penetration of a mass of bowlders of all sizes, some requiring blasting for their removal. The aggregate weight of the superstructure was 3,500 tons of iron and steel. The 1900 ft. of iron viaduct was completed between Aug. 1 and Sept. 10; the two 175 ft. deck spans and the adjoining 250 ft. deck span were erected between Sept. 10 and Nov. 15; and commencing on the last date, the first 400 ft. span was completed in the early part of December. The whole bridge would have been completed by Jan. 1 had it not been for some delay in shipments and the furious winter weather which set in about Dec. 19; between this date and Jan. 19 there were really but 7 good working days; the thermometer registered 24° below zero, and much of the time the iron work and all about it was coated with ice and sleet making work impossible. When all things are considered the work done at Sibley is a thing that engineers and contractors can well be proud of.

LATEST reports from the Northwest state that there is some prospect of the war in freight rates reaching a speedy termination. As the rate of loss to the companies under the present reduced traffic rates is estimated at $50,000,000 per year, this will be welcome news to holders of railway stock.

The Poughkeepsie Bridge.

The illustration herewith given shows the present status of work on the Poughkeepsie bridge and is reproduced from a late photograph taken from the river on the ice by one of the assistants of Chief Engineer J. F. O'ROURKE.

The view shows the west end of the bridge with the west cantilever and west connecting span completed. It should be noted that the iron towers supporting these spans are still partly concealed by the timber false works about them and which have yet to be removed.



The Poughkeepsie Bridge, Jan. 1, 1888.

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The Use of Lead in Compression Tests.

Prof. UNWIN, in a paper before the British Association condemns the use of sheets of lead in the attempt to secure a uniform bearing for material being subjected to a test by compression. He says a thin bed of plaster is much better and with it parallel faces for the specimen are easily secured. The use of sheets of very hard cardboard instead of iron plates on either side of the test specimen is also recommended.

To prove the correctness of his observations, Prof. UNWIN compares the results obtained with the two methods, from cubes of Portland stone and Yorkshire sandstone, 4-in. on a side. The crushing pressure required when the specimen was placed between sheets of lead, was in the one case three-fifths and in the other case three-sevenths of that required when the cubes were prepared with plaster and cardboard. One cube was carefully cemented between two rigid plates of iron with parallel faces; it had a very little more resistance than when plaster and cardboard were used.

An examination of the fractured cubes explains the evil effects of the leaden sheets. Cubes crushed between sheets of cardboard give way at about an angle of 45° and form a regular pyramid. While when lead is used they show a great number of prisms on end with almost vertical faces. The lead flows under the pressure, and by friction on the solid material exercises a force which is, in a sense, perpendicular to the crushing force; the cube when thus fractured has its angles of fracture much modified. Lead flows under a pressure somewhere between 3,413 and 6,826 lbs. per sq. in.; pressures which are often exceeded in these experiments.

What has been said of lead will naturally apply to all other plastic or compressible material used in a similar manner. But if we would exactly measure the crushing value of certain building materials, we must not avoid precautions the use of which would tend to better results.

—o—

Tests recently made at the Watertown Arsenal, show that plain wire nails coated with Trinidad asphalt, under COPELAND'S patent, have a much greater adhesive resistance in wood than similar or cut nails uncoated. In white pine, the comparative power required to pull out plain wire, cut and coated wire nails respectively was as follows: 89, 128, 265 lbs.; or, 238, 278, 914 lbs. per sq. in. of surface of nail in wood. In white oak, the latter figures stood, 804, 925, 105 lbs. per sq. in. of surface. In white pine, the average of a number of experiments gave per sq. in. of nail surface in the wood, 667 lbs. for the coated nail, 308 lbs. for the cut nail and 280 lbs. for the plain wire nail.

Brick and Stone Bridges of Large Span.

According to Prof. E. DIETRICH, of Berlin, there are only fifty-seven bridges of brick or stone existing having a span greater than 131 ft. Forty of these have spans lying between 131 ft. and 164 ft., ten have spans of from 164 ft. and 200 ft., three of from 200 ft. to 230 ft., and one only, the Cabin John Bridge, near Washington, exceeds this limit, and has a span of 237 ft. Thirty of these are road and twenty-two are railway bridges; one carries a canal, another a conduit, and three are not classified. Fourteen of them date from before the commencement of the present century, twenty-two were built between the years 1800 and 1860, five between 1860 and 1870, six between 1870 and 1880, and since then ten have been erected. In twenty-two of the bridges the rise lies between half and one-third of the span, in eighteen between one-third and one-fourth the span, in ten between one-fourth and one-fifth the span, and in six between one-fifth and one-eighth the span. One bridge only, a road bridge in Turin, has a flatter arch than given by the smallest of the above ratios, and in this case the rise is $\frac{1}{8.18}$ the span. The radius at the crown lies in fifteen cases between 66 ft. and 98 ft., in eight between 98 ft. and 131 ft., in eleven between 131 ft. and 164 ft., and in three cases between 164 ft. and 187 ft. 8½ ins., the latter being the radius at the crown of the Devil's Bridge at Bevizzo, Italy. The ratio of the arch at the crown to its radius at the same point is in thirty bridges between one-tenth and one-twentieth, in ten between one-twentieth and one-thirtieth, and in eight between one-thirtieth and one-thirty-fifth. In all the railway bridges this ratio lies between one-twentieth and one-thirtieth, the smaller fractions being solely confined to road bridges. Twenty-seven of the bridges are situated in France, thirteen in Italy, ten in England, two in Austria, two in Spain, and one each in Germany, Switzerland, and the United State.—*Engineering.*

Maps of the English Ordnance Survey.

London *Engineering* commences in a late issue a description of the various processes used in the reproduction of the manuscript maps of the Ordnance Survey. From the first article we make the following brief abstract:

The first Ordnance map sold to the public was published in 1801; it was engraved on copper to the 1-in. scale, and this scale and method of reproduction was continued until 1853, by which time the whole area of Great Britain had been so mapped and issued. The counties of Lancashire and Yorkshire and the other Northern counties and the whole of Ireland were also issued on a scale of 6-in. to the mile.

In 1854, it was decided to survey, on the $\frac{1}{2500}$ scale, all England south of Lancashire and Yorkshire and certain portions of Scotland. Lithography was now adopted as more economical and rapid and as removing some of the difficulties arising from the shrinkage of the paper in printing from plates. This process was, however, soon replaced by zincography, and photographic reductions to the 6-in. scale were engraved on copper. In 1882, photozincography was introduced, and engraving on copper has been since confined to the completion of the 6-in. scale maps.

The various processes now in use and the kind of map published by means of each is given as follows:

(1) *By copper-plate engraving combined with electrotyping.*—New series 1-in. Map; 1st. in outline, and 2nd. with hills; 6-in. maps of certain counties. Four miles to the inch map. Ten miles to the inch map.

(2) *Zincography.*—Ten feet to the mile plans of towns ($\frac{1}{500}$ scale). "Parish" plans, 25 in. to the mile ($\frac{1}{2500}$ scale).

(3) *Photozincography.*—Six inches to the mile map for counties not engraved on copper. Index maps.

The manuscript map is always plotted on the $\frac{1}{2500}$ scale (excepting the town plans, which are plotted to the $\frac{1}{500}$ scale) and all the smaller maps are obtained by photo-reductions; thus, the 6-in. maps are reduced from the $\frac{1}{2500}$, the 1-in. from the 6-in., and so on. These manuscript maps are all based on the most accurate surveys, checked in every manner possible and depending ultimately on the "Great Trigonometrical Survey of Great Britain and Ireland," commenced in 1784, and completed in 1858. This survey was so accurate that the difference between the six-mile base line on Salisbury Plain and the calculated length obtained from the Lough Foyle base through the intermediary of this triangulation was only $4\frac{7}{10}$ ins.

The remainder of the series of articles in *Engineering* is to be devoted to the detail of the processes used in transferring, reducing, engraving and publishing these maps.

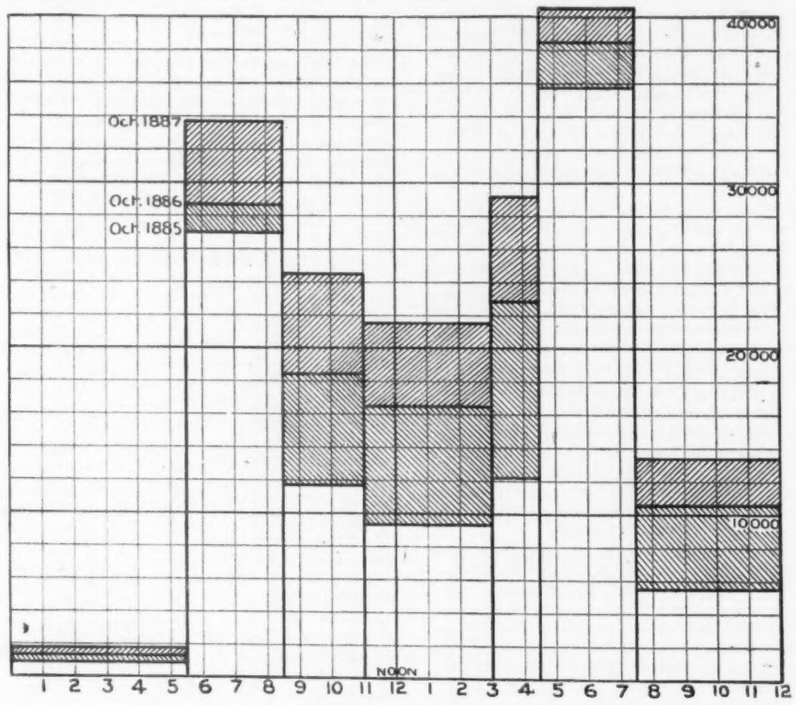

Fig. 1.—Average Number of Passengers per Hour of the Brooklyn Bridge Cable Cars for Various Periods of the Day.
Showing its growth since October, 1883.

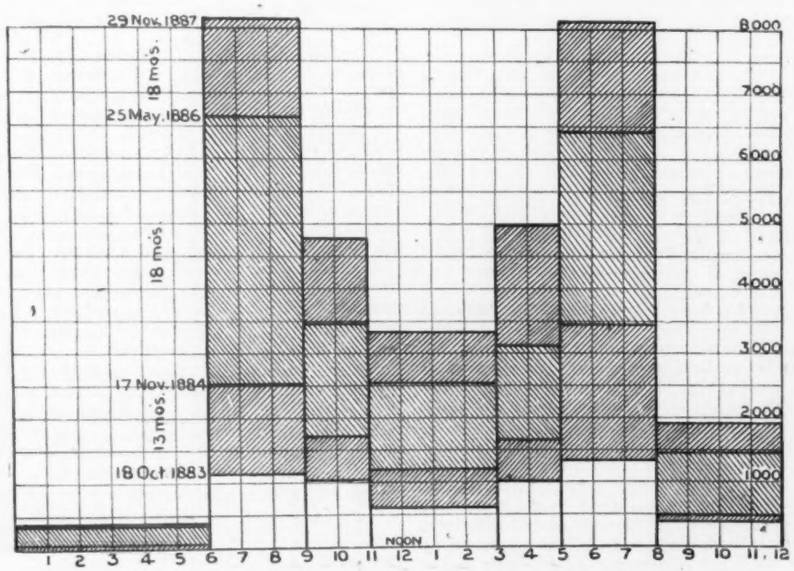

Fig. 2.—Average Number of Passengers per Hour of the Manhattan Elevated Railway, All Lines, for Various Periods of the Day.
Showing its growth since October, 1885.

THE total of transactions on the New York Stock Exchange on Tuesday, Feb. 14, aggregated 37,000 shares, the smallest day's business recorded for many years.

Burmese Geology.

The following literal potpourri is found in an official report on the minerals of Upper Burmah, published in the *Indian Engineer*; it is supposed to name the most accessible of the groups of coal outcrop:—

The Pagamyaungchaung Group.
The Mithinchetkyauk Group.
The Ingôndaung Group.
The Thabyetaungdan Group.
The Gyobinmyaungchaung Group.
The Gyobinmyaungmachaung Group.
The Chakimyaungchaung Group.
The Thaikthaw Group.
The Kyathaungdaung Group.
The Chanlemyaungchaung Group.
The Ludwin Group.

We trust that the outcrops are more "accessible" than the geological nomenclature of these particular groups. The Burmese geologist has our sympathy.

Diagram of New York City Passenger Movement.

The diagrams which we publish this week tell their own story so fully, to those who take the trouble to study them with care, that much comment is unnecessary. For the information from which they are compiled we are indebted to Col. F. K. HAIN, General Manager of the Manhattan Railway, whose skillful and careful management of the operation of the lines has extended likewise to more than usual care in the preparation of statistical records. We have selected the months of October as a fairly typical month of the whole year in preparing the diagrams.

Perhaps the most striking and interesting fact shown is the enormous proportion of the elevated traffic which originates in the vicinity of the City Hall, and in the (in area) very limited region below it. The single station at Chatham Square (there are some 98 in all), does nearly 10 per cent. of the whole business of the Manhattan system. The little point of the island below the City Hall originates as much traffic as the first mile belt above it of nearly five times the area; and the two together originate 59.1 per cent. of all the up-town traffic in the city. To appreciate what this means fully, a map of New York should be studied in connection with the diagrams.

Many people have an idea that business in New York is tending strongly up-town, and that the 14th and 23d st. stations are among the most important in the city. The facts are visible on the diagrams and anything but support this conclusion.

The distribution of the down-town traffic is also curious. The influence of Central Park, and the small percentage (only 12.9 per cent.) which originates below 20th st., are very notable. The apparently irregular way in which the traffic of the different stations varies, is also curious.

The distribution of the traffic and of the growth therein between different hours of the day is shown in Figs. 1 and 2 and the contrast in this respect between the Manhattan Railway and the Brooklyn bridge is very striking indeed. There will be different interpretations put upon the facts, nor is it possible to interpret them exactly.

To us it seems that this is the most probable interpretation:

The rush-hour traffic of the Manhattan has not grown much, because it can't. It has grown more large evening travel of the Manhattan is especially notable. It is the enormous growth of this off-hour traffic which has made the 5ct. fare so profitable.

The Brooklyn bridge diagram, Fig. 1, was made up from the data given in the diagrams for the traffic of each hour given last week, which were recast into periods of several hours each to correspond as nearly as possible with the Manhattan railway diagram. The off-hour traffic will be seen to be materially less in proportion than on the elevated lines, as is natural under existing conditions. The growth of the traffic has likewise been even greater in the rush-hours than in the off-hours. This we take to be because the traffic of the bridge is in much larger proportion necessary business travel, the existing conditions tending strongly to discourage occasional or avoidable trips. The enormous jump in the bridge travel from 1884 to 1886, as we said last week, is due to a change of conditions from 2 car to 3 car trains and from 5 ct. to 3 ct. fares. At the first and second date given, and at the third and fourth, the conditions were practically the same.

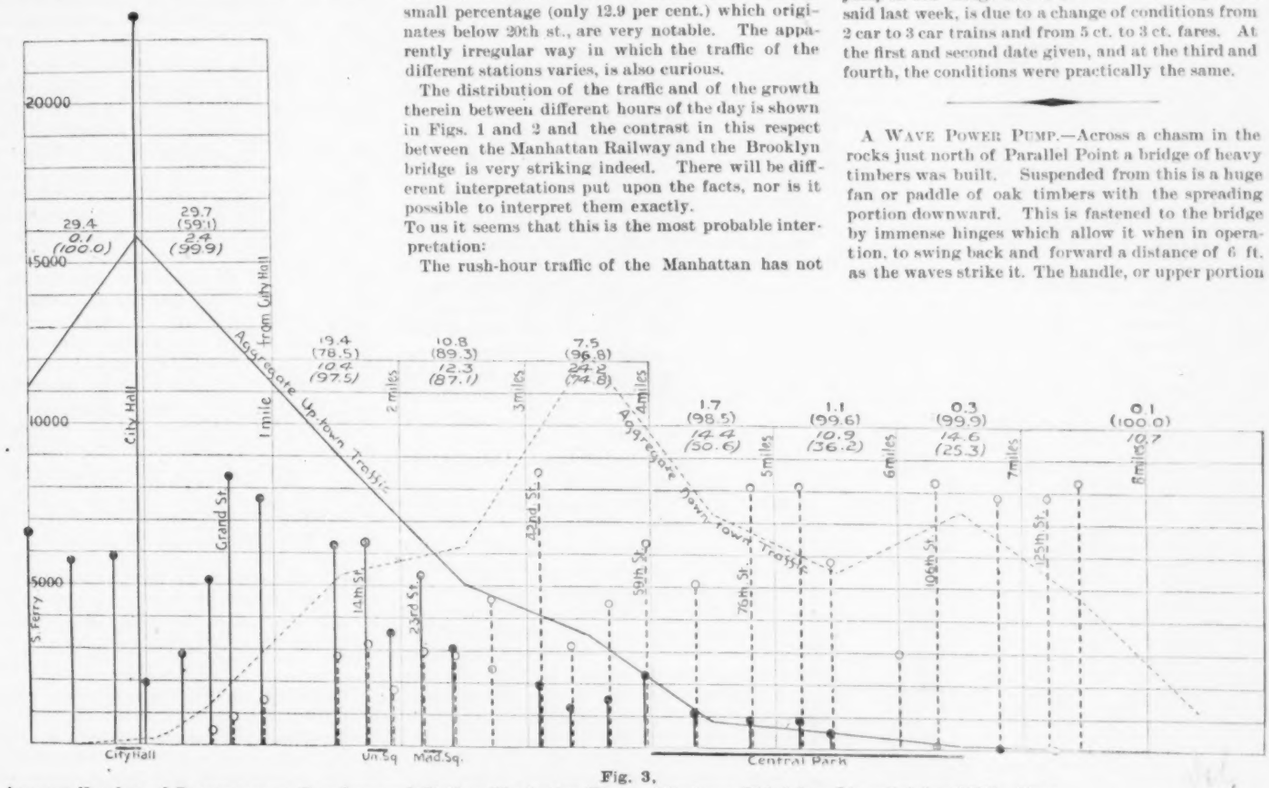

Fig. 3.

Average Number of Passengers per Day from each Station, Manhattan Elevated Railway, Third Ave. Line: October, 1887. Also:

Average Daily Aggregate Passenger Movement of All Lines, Originating from Stations in Each Mile Belt above and below the City Hall. (aggregate movement plotted on *one fifth* the scale marked.)

Percentages of Up-town Movement originating on each mile are shown in upright figures, and of Down-town Movement in slanting figures. *The total percentages* of the whole traffic originating back of and including each mileare given in (parenthesis).

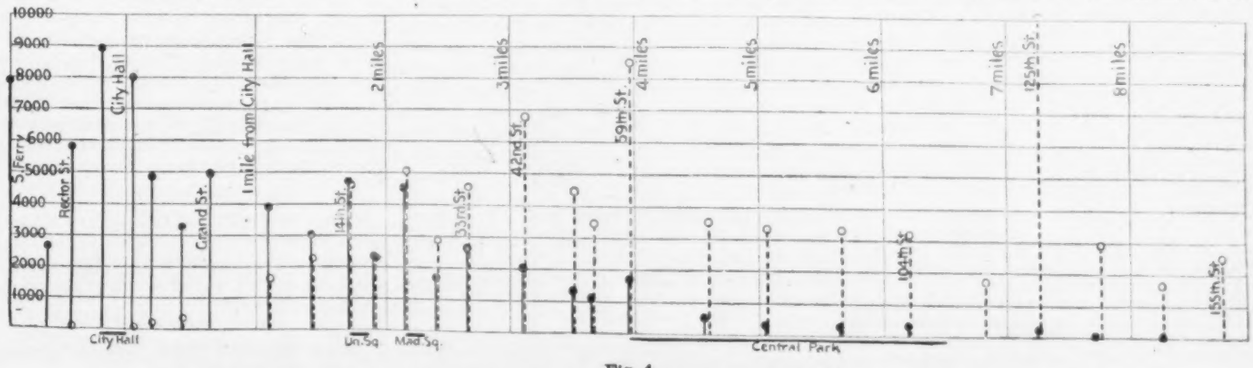

Fig. 4.

Average Number of Passengers per Day from Each Station, Manhattan Elevated Railway, Sixth Ave. Line; October, 1887.

A WAVE POWER PUMP.—Across a chasm in the rocks just north of Parallel Point a bridge of heavy timbers was built. Suspended from this is a huge fan or paddle of oak timbers with the spreading portion downward. This is fastened to the bridge by immense hinges which allow it when in operation, to swing back and forward a distance of 6 ft. as the waves strike it. The handle, or upper portion of the fan is connected with a solid plunger pump 12 ins. in diameter and having a stroke of 9 to 12 ft. This pump, in turn, is connected with a suction pipe running out into deep water. The fan is so rigged that it can be drawn up out of reach of the waves, when not in use. When a wave comes in, the fan is thrown forward and forces the air out of the pump barrel in which the plunger works. On the wave receding, the fan is carried seaward and the plunger drawn out, causing a vacuum, and causes a quick rush of water into the suction pipe. The force with which the water is drawn up is sufficient to raise it to an elevation of 350 ft. above the sea level. —*San Francisco Call.*

ENGINEERING NEWS

TRIBUNE BUILDING, NEW YORK.

VOL. XIX., Saturday, February 18, 1888.

D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.
GEO. H. FROST, - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year; $2.50 for Six Months; $1.50 for Three Months; Single Copies, 12 cents.* FOREIGN COUNTRIES, $6.50 *per Year, or 3 cents per number additional.*

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Coming Technical Meetings.

Engineers' Club of Philadelphia, Pa.—Regular meeting, Feb. 18. Secy., Howard Murphy, 1122 Girard St.

American Institute of Mining Engineers.—Annual meeting at the Institute of Technology, Boston, Mass. Feb. 21 to 25. Secy., A. Raymond, Burling Slip, New York City.

Civil Engineers' Club of Cleveland, O.—Regular meeting, Feb. 28. (Architectural branch of the club) Secy., C. O. Arey, 31 Blackstone Building.

Engineers' Club of Kansas City, Mo.—Regular meeting, March 5. Secy., Kenneth Allen, 19 Deardorff Building.

Engineers' Club of St. Louis, Mo.—Regular meeting, March 7. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, March 7. Sec., John Bogart, 127 E. 23d St.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, March 21. Secy., S. E. Tinkham, City Hall.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Master Car Builder's Association.—Next convention at Alexandria Bay, N. Y; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reed, Waycross, Ga.

The following letter from the President of the American Society of Civil Engineers in respect to the advisability of raising the standard for admission to the two higher (existing) grades of membership in that body, and creating a new and lower probationary grade of Students, the ballots in respect to which have been sent out this week, was received after the circular had been printed which has been sent to all Members, and hence neither the letter nor Mr. KEEFER's signature could be appended to the circular. We reprint the letter here, however, as a matter of general interest, and sincerely trust, for the sake of the Society, that all members will vote in accordance with its suggestions.

OTTAWA, Feb. 6, 1888.

ROBT. E. MCMATH, Esq. St. Louis, Mo.

Dear Sir:—I beg to acknowledge yours of 2nd inst. with enclosure which I return signed.

I think the strongest arguments in favor of a Student class are that it will be a recruiting agency for the Society all over the Continent: that the reception of our Proceedings by them will lead to their perusal by their employers who are not Members, and thus secure additions to the higher grades of Members; and that all who join as Students will, if they live, ultimately become Members. Of the 900 Student members of the English Institution a considerable number every year pass up into the higher grade. It is objected that young beginners will through the establishment of a Student class, be enabled to pass themselves off as "belonging to the Society" and be mistaken for Members. I do not think the engineers would thus be deceived, and as to the public it has no means of judging between us but that of age and reputation. Our classification would tell against the Student assuming too much, rather than in his favor. In a sense they would be "Members," but only as in a bridge truss, "where all members have not the same office." It is also objected that the Students would "flood the Society" at meetings and conventions, but this is entirely under our own control, and they can be excluded when necessary, although, looking to the limited numbers in reach of either, I do not apprehend any danger from this source. None has been found in the English Institution, where the system has had a fair trial. Very truly yours, THOS. C. KEEFER.

A brand new rapid transit scheme by Mr. HEMAN CLARK, the well known Aqueduct contractor, which makes Mayor HEWITT's seem picayune, is announced with a flourish of trumpets by the *Tribune*. It is nothing less than 15 miles of four-track tunnel, 150 ft. below the surface, from Fleetwood Park in the "Annexed District" under the Harlem river; down "back-bone of the island" to the Astor House; thence by a two-track tunnel under the Hudson river to the "meadows" back of the Palisades, and by another two-track tunnel under the East river to "near Prospect Park." There are to be 25 shafts for passenger business and a like number for "freight pockets" which are to be at the end of as many stub branches, 500 to 1000 ft. long, for holding freight cars.

As the *Tribune* well says, these plans "almost take one's breath away;" but the plan has all the usual concomitants of "enormous capital behind it," for "the men who are behind it can easily figure up $100,000,000 from their available resources." Perhaps when their grand project is finished they will not be able to "figure up" so much. There will be "no trouble about ventilation," because Mr. CLARK has observed a draft through the Aqueduct tunnel "strong enough to take your hat off," and the cost will be only $30,000,000 of which only $13,200,000 is for tunnel excavation and $6,500,000 for lining. "Prominent engineers" have already been conferred with, and all that is needed apparently is for Mr. CLARK to finish up his Aqueduct work and have his hands free for this new project. In view of the completeness with which this "well developed plan" is already worked out, the sum of $300,000 for "engineering" and $500,000 for incidentals" seem unnecessarily liberal. Mr. CLARK has so far been his own engineer, and he should continue so. All he will then need will be a few peg-stickers and computers, like Col. HASKINS of prior tunnel fame.

THE Board of Estimates and Apportionment of this city, reported lately that the original contract price of the Manhattan bridge over the Harlem river, $2,055,000, had been increased by the Commission by $428,757 in order to secure deeper foundations and better work. The request of the Commission that $700,000 construction bonds be issued in addition to the $1,800,000 already out, was objected to by some of the Board on the ground of this sum exceeding the contract price, and the matter was referred to the Corporation Council for an opinion regarding the extent to which the city is bound by this action of the Commissioners of the bridge.

The comment may be made upon this, that if the $2,055,000 was a fair bid on the original design and specifications for this bridge, and it is accepted as such, the bridge Commissioners and their engineers have done wonders with the additional $428,757. A comparison of the plans upon which the contract was let and the work as it stands will make this plain. In the main piers we see handsome cut stone moulding and magnificent granite ashlar replacing ugly coping courses and very ordinary gneiss rubble masonry. So, too, where the approaches called for blank walls of a similar gneiss rubble, we see arches of most excellent design and construction carrying the best quality of masonry. It should be also considered that when the contract was let, the method of founding the east main pier and its cost were utterly unknown quantities, and the specifications mentioned no plan of so doing. The Commissioners' engineers wisely selected the surest and safest plan, and we understand that the bulk of the extra expenditure went into this foundation. In fact, the great change in quality and style of the work above ground has been effected at a cost of only 12 per cent. advance upon the original bid for this part of the work.

At the time this contract was let, we strongly condemned the design and general character of the masonry as utterly unfit for the proposed site, and as a disgrace and reproach to the great city which was to pay for it. Its shortcomings would have been intensified by the grace and finish of its ancient neighbor, the High Bridge, and it would forever have been a blot in the fair surroundings. The original blunder of starting out with an unworthy design, is in a great measure wiped out by the later wisdom which has led the Commission to build a very handsome bridge; and when the change in design is compared with the increased cost, no one will deny but that the city has made a good bargain after all. In the present case the city has a bridge which it can well take pride in; in the other case it would have paid over $2,000,000 for a structure that would have been a standing reproach to the good taste and common sense of every one connected with it.

THE New York Board of Aldermen very naturally resents the suggestion and action of Mayor HEWITT in regard to the center-bearing rail on our streets, for the compulsory removal of which a bill is now pending in Albany. The members claim that the Board is the proper body to pass upon the character of the rail to be used, and one Alderman further objected to the interference of Commissioner Newton because "he could not poll a half dozen votes in his own district." That is just it; if the Aldermen paid more attention to the comfort of the public and showed less tenderness in hurting the feelings of individuals and corporations controlling votes, the action of Mayor HEWITT and Commissioner NEWTON might have been unnecessary. The street railway companies also claim that it would be an injustice to put them to the expense of laying a new form of rail; but, when it is considered how much rail they have saved in these long years by forcing general traffic off from their rail by the cunningly and specially devised form they gave it, the injustice is not so apparent.

WE are compelled by inability to spare the space, to postpone the continuation of our discussion of the Quaker Bridge dam question, which we stated would appear this week, to a following issue.

Mayor Hewitt's Rapid Transit Scheme.

It is refreshing to see the best traditions of the office which was once filled by DE WITT CLINTON, revived at last, after being so long in abeyance, by a Mayor who seems to realize that the office is essentially a non-political and administrative one, established to aid the proper conduct of the city's business affairs only, and who acts accordingly. It is perhaps

the first time in the history of New York that a four column message has been exclusively devoted to great business questions affecting the whole population, brought forward solely in their interest, without party or individual axes to grind thereby. Such we fully believe the Mayor's message to have been, and it would have commanded correspondingly great public interest and approval, even had its suggestions been less shrewd and sensible than they are.

By far the most important feature of the message was the project for a great system of rapid transit, to be built and owned by the city. Its main features have been received with almost unanimous public approval, in which we certainly join, as we said last week, but the Mayor would have been successful indeed had he not fallen into some mistakes of detail, and we may add,—if he had not seemed to others to have fallen into more than he has, for opinions will differ. But if such a large-sized project is to be discussed at all, with any better purpose than merely to say something, it is inevitable that the discussion should have more or less of a fault-finding tone, since it is useless to say much about those features of the plan which seem good, while those that seem bad must be discussed somewhat at length to show wherein they are bad. Premising once for all that the essential features of the Mayor's project seem to us admirable, and passing the question of constitutional authority to carry it out, which we presume can be had, we propose to comment chiefly, for the above reasons, on what seem to us the *bad* features of the project as outlined.

The selection of the New York Central Railroad Company as the preordained instrument to carry out the project seems both unfortunate and unnecessary. The alleged grounds are the "absolute financial responsibility" of the company, and its present possession of a two-track road on the west side and a four-track road on the east which may be utilized for rapid transit purposes. But the "financial responsibility" of any company can be sufficiently guaranteed during construction by the deposit of a million dollars or so, and will be amply guaranteed during the period of operation by the security of the rolling stock, if so provided in the contract. The possession of the existing lines referred to is a more important reason, but if, as the Mayor says, the outer tracks of the four track road from the Grand Central station cannot now be properly utilized "for the reason that the accommodation at the station will not permit the trains to be run with sufficient frequency to be of much use to the public", and if they are to be "shut off from the other tracks" and carried "under the Grand Central station" so as to be operated entirely independently of the existing station work, there is no apparent necessity for the Central to control the handling of those tracks or the traffic over them, nor would they probably have any great desire to, as their business is already vast enough for one corporation to conduct, and this proposed addition would be a great business in itself, handled under quite different conditions and quite different rules from those which prevail in ordinary railway operation, so that efficiency and skill in the one would not at all argue skill in the other. As the city has already invested $3,000,000 in these tracks there should be no difficulty in effecting a separation of interest to the extent of allowing the city to control them for rapid transit purposes, for some years at least, and certainly it has an equitable claim for such an arrangement.

As for the west side tracks, there might certainly be an *immediate* convenience in their utilization for rapid transit purposes as proposed. But looking ahead only a few years, when Manhattan Island will be covered with buildings, it will be seen that these surface tracks are entirely inadequate for many reasons, for permanent requirements, and that the natural growth of the traffic they now carry is as much as they should be loaded with, if indeed even that should be permitted to be permanent. Why then complicate matters, and do harm in the end, by adapting the *permanent* system to lines which can at best serve but a temporary purpose, and which do not run where such a line should lie? If there be anything which can be considered as permanently settled by experience, it is that city transit lines, to be most successful (*i. e.* to accommodate best the largest number of people) must be carried, as nearly as may be, through *the center* of the population served for its whole length, or as the Mayor says:

"Third—The route, when laid out, must be located where the public want to go, and not on a route which takes them away from the center of business or unnecessarily lengthens the distance."

We are inclined to believe that, looking ahead only a few years, the outer pair of the four Grand Central tracks, will have full employment in handling the traffic *to points beyond the Harlem river only*, and that an independent extension up Madison or Lexington Ave. will be expedient and necessary for the local Manhattan Island service. If so, a temporary arrangement to utilize the Grand Central tracks for both through and local service, might be convenient and desirable, but it would not involve the unpleasant alternative of trusting to the tender mercies of the New York Central for 35 years of rapid transit accommodation.

Without indulging in needless acrimonies, this would be a public calamity. The New York Central has rarely shown a progressive, liberal or accommodating spirit in any of its dealings with the public, either in great things or small. It introduced sleepers—when it had to; it has improved its Wagner cars so as to be only *a little* inferior to the Pullman,—after their great inferiority had become notorious and costly; it introduces limited trains—after the Pennsylvania; and vestibule trains—after competition compels it to. It owns the Fourth and Madison Ave. horse-cars—or rather its owners do—and that highly profitable line is perhaps the most shameless offender in the city in respect to the excessive overcrowding of cars run on needlessly long headways, as conspicuously in the evening and on Sunday. It is too great a corporation to be effectively controlled by the city, and in combining an entirely new and different business with its present enormous aggregate, and one without the stimulus of competition which keeps its other service passable, there would be scant hope of really good rapid transit accommodations.

A smaller independent company of sufficient responsibility will certainly be found to accept the Mayor's proposition if it is once put in definite shape. The route proposed is the best one for traffic in the city. The present earnings *per mile* of the whole 32.4 miles of the Manhattan Elevated are at the rate of about $240,000, expenses $130,000, leaving $110,000 net. The cost of a four-track underground road with no right of way expense (which we shall see is unnecessary) should not much exceed $2,000,000 per mile, rental on which at 5 per cent. is $100,000 per mile *for a four-track road*. But the earnings of the Manhattan on the Third and Sixth ave. lines only are much in excess of the average of the whole system, or nearly $200,000 per mile. The new lines (properly laid out) will have an advantage over even the Third ave. in route, a second advantage in handling much longer trains, a third advantage in running faster. It will draw the cream of the traffic up to the limit of its capacity, and its earnings could not well be *less* than $150,000 per mile of double track, or $300,000 per mile in all, bearing in mind that the per cent. of operating expenses to revenue will be less than on the elevated, because of hauling so many more passengers per train. It is quite possible that earnings would rise within five years to $400,000 or $500,000 per mile.

Heavily discounting these estimates, enough remains to attract a responsible independent company under the Mayor's shrewd proposition; the city to borrow the money at 3 per cent, lease at 5 per cent., and devote 2 per cent. to a sinking fund, which will give it the ownership of the lines clear of encumbrance in 35 years. A still better arrangement ought to be possible if the contract is opened to public competition in a definite way, but that is good enough.

The Mayor's proposition is to carry the two outer Grand Central tracks under the station. Thence:

"Under the present tunnel from 42d St. to 34th St., and thence along the center of Fourth Ave. to 9th St.; thence into Lafayette Place; thence under Lafayette Place, and thence through a new street, connecting with the Elm St. improvement to the City Hall and Brooklyn Bridge terminus. It will be remembered that the Fourth Ave. above 33d St. is 140 ft. in width, the additional 40 ft. having been provided for the tracks of the railway. In opening the new street from Lafayette Place to the City Hall the same width might be adopted. This would enable the four tracks to be constructed in the center of the street through an open cut, for which 50 ft. would be required, leaving 90 ft. to be divided between the two sides, or 45 ft. of street and sidewalk on each side. From Lafayette Place along Fourth Ave. to 32d St. the four tracks would be made in a subway. The open cut portions of the route would, of course, require no provision for ventilation or light. The tunnelled portion would be lighted by electric lights and ventilated, as the Mersey tunnel now is, by fans properly constructed.

If any considerable part of the line is to be in tunnel, however, it might just as well, and better, be all in tunnel. The electric light must (practically) burn constantly anyway, and the transition from tunnel to open cut and *vice versa* is more disagreeable than either constantly, as the approach to the Grand Central depot shows. The Mayor's suggestions as to motors and ventilation are well put.

If all underground, the costly strip of land 50 ft. wide from Lafayette Place to the City Hall, with its unsightly open trench, and great reduction of the narrow building area between the new Elm street and Broadway becomes unnecessary. Such a trench would seriously injure the street for business purposes, apart from its great cost.*

The worst of all defects in the Mayor's plans, however, seems to be the arrangements proposed at the lower end of the city, and these seem to come from what we regard as a fundamental misconception of what the people want and will use. The Mayor proposes in terms to stop his rapid transit line at the Brooklyn Bridge terminus; to have a subsidiary horse or cable car surface service to bring passengers to it from the lower part of the city, and to distribute a good part of his traffic uptown by subsidiary horse-car or elevated service of the same kind. This, in our belief, will not do. It would ruin the line as a busi-

*We are not able to agree with the Mayor that it is *necessary* for the rapid transit that:

Second—"The rails must be laid on an absolutely solid foundation, and this means that they must either be laid below the surface of the streets, or, if placed above, upon an embankment so solid as to be equal to the stability of an underground line."

A properly designed high viaduct road carried on brick piers in the center of each block, or about 260 ft. apart on an average, and passing completely above ordinary buildings, has every practible capability of the plans thus outlined in the way of the high speed and durability, is probably cheaper, and has many arguments in its favor. For the particular route now proposed, however, the underground plan is probably preferable, so we may pass that question.

ness enterprise. According to our observation the settled practice of 99 in 100 city passengers is to *walk* at each end of their route to the nearest means of transit by which *at a single trip* they can be carried over the largest possible fraction of their total trip without the annoyance, expense and delay of transfer. But the Mayor even proposes that a large part of this traffic shall be carried by horse-car as far as to Grand St., at an extra charge of 3 cts. Such arrangements would be sure to fearfully cripple the earning capacity of the line.

The true arrangement, we take it, is this: Four tracks from the Grand Central station to the Brooklyn Bridge terminus, the two local tracks terminating there, since it will always be an enormous center of traffic, as the diagrams in this issue show. With the approaching very great enlargement of the bridge capacity it will become still more so.

The two express tracks should then be extended on through the proposed new street between Nassua and William Sts., to its probable terminus at Maiden Lane or Liberty St., where the grade is quite low; thence by a short tunnel under the intervening high ground, regardless of street lines and buildings, to Broad and Wall Sts; thence through Broad to South Ferry. Running the trains local over these tracks as far as the bridge terminus (with say two or three stops) they will be packed by the time they leave the latter point, and may thence run express. The traffic from this lower section is enormous (see diagram) precisely that which most needs express service, while the delay *for two or three down town stops only* is not a serious matter, and an immense accommodation. Long experience has settled that this way of handling traffic, running local for a few stations, and thence express, is by much the best under analogous conditions.

The Mayor objects to underground service in this down-town section, on the singular ground that "Local distribution made in tunnels is objectionable, for police and many other reasons. *In fact, it would be necessary to station a police officer at every stopping place within the tunnel.*", Supposing it is; the expense is but a trifle in the aggregate, but as underground service is proposed over about half the route it is no worse in one place than another, and in fact is less objectionable the greater the crowd at the station. The electric light seems to remove most of the difficulty, and make police officers no more necessary underground than above ground, since there must always be a force of employés about to guard against secret crimes of violence.

The Mayor also objects to the proposed new street, saying:

> "As to the proposed extension of Elm St. to the south, there never has been sufficient evidence to enable an intelligent man to decide whether it would repay the cost or not."

We think the question stands thus: The destiny of lower New York is fixed; it is to be more and more a vast office section, only the lighter trades, like jewelry, remaining in it. By the constant addition of enormously high buildings its business population has already more than doubled in 20 years, and it will double again in as many more, perhaps. In the end it will be several times greater than now, on the same area. The office population tends to huddle together for convenience of inter-communication, and it is extremely improbable that for a century to come its center will move above the City Hall even if it becomes ten times as great as now. The careful student of the city's tendencies will hardly question this.

The growing necessity, therefore, is for more sidewalk room rather than more teaming room, since the latter relatively decreases. The whole region east of Broadway, which especially tends to become one vast office section, is held back and injured by the narrow *sidewalks*, rather than roadways, of Nassau and William Sts., since it is useless to erect many buildings for multitudinous tenants where there is not sidewalk room enough to give access to them. The coming multiplication by six to ten of the Brooklyn Bridge capacity will increase this evil and necessity.

Another requirement of these great office buildings is abundant light on all sides; in other words, SMALL BLOCKS. The new street, therefore, will not use up much available building area, since an equal space for light and air alone must be left in courts and back yards, which may as well not be made useful also for street purposes.

Under these conditions the new street, if laid out, should have wide and ample sidewalks and relatively narrow roadways. It should properly extend through to Wall St., but if that seem too expensive, the *main* need for the street can be met at small cost by simply opening a covered way for foot passengers, some 20 or 25 ft. wide, through the blocks from Maiden Lane to Wall St., as is often done in other cities, leaving to the future the question of carrying the entire street through. Laid out thus, it will speedily become a very important street for foot travel and retail trade, and will be speedily lined with high office buildings, relieving all the overcrowded north-and-south streets, and greatly increasing the value of all surrounding property; while it is difficult to see how the necessary crowd can *comfortably* reach the bridge terminus, after all has been done which can be done, without some such improvement.

We have left ourselves no space to speak of the up-town features of the Mayor's project, which are open to much less serious criticism, and may perhaps be just as well passed by for the present. One more point only demands comment:

The Mayor's alternate proposition, which he evidently prefers, is to put only two tracks up Elm St. and Fourth Ave., and carry the other two tracks down Broadway. This he evidently feels, in fact, says, will be a final settlement of the whole rapid transit question.

The present elevated lines were also thought to be a "final settlement," although half their present traffic was not dreamt of. It is difficult to persuade the public to look very far ahead of its nose, and we shall perhaps be laughed at for asserting that, if the Mayor's new lines are built at once, half the remaining fragment of this century will not have passed before we shall be in worse state than we are to-day. That is to say: the bulk of the present long-trip elevated traffic will go at once to the new lines, and fill them to repletion. The elevated traffic will not fall off, however, any more than the street traffic car has, but an *entirely new* traffic, largely short trip, will develop for them, now driven away, and largely killed, by the impossibility of accommodating it.

Without discussing these probabilities further, *if* they are real, a four-track road down Elm St., and another one from the West side down Broadway to Union Square, and thence down University Place and West Broadway to the Battery, will be the better eventual plan, with perhaps a two-track road on lower Broadway in addition. The difficulty of arranging for convenient access to four-track roads, to which the Mayor alludes, is real, but by no means insuperable. The most important and essential of all, as we shall show more fully within a few weeks, will be a four-track Elm St. line. By building that four-track now, we serve *nearly* as well all present requirements, and do not block the way to a future great expansion as outlined, as we should most sadly by putting only two tracks in Elm St., to serve merely the needs of the moment. We trust, therefore, that the Mayor's first proposition and not his subsequent alternate, will be the one chosen, albeit either is better than none.

The Proposed Corps of U. S. Civil Engineers.

While we heartily approve of any movement tending to introduce better system into the conduct of our public works and a concentration of the responsibility which is now divided among bureaus of distinct departments, the first practical step in this direction is open to some criticism. We refer to the bill of the Hon. CLIFTON R. BRECKINRIDGE, elsewhere given in its salient features.

The chief objection to this bill is that it would serve to benefit a few individuals rather than the great general public which suffers by the present mixed condition of control; it is not broad enough, even for a begining. As it now reads, the immediate effect would be to depose the Army engineer from his present supervision over public work and substitute for him a new organization which would place all engineers on a footing of equality, but otherwise leave the corps to go on in very much the same old lines. It is a change in name and personal standing, in fact, rather than a thorough reorganization on a basis which would really benefit the service.

The intention of the proposed bill is good and the extinction of any class difference among the engineers would form part of any comprehensive reorganization scheme. But this bill would retain, and in a degree intensify, one of the most objectionable features of the Army organization, and that is promotion by seniority without regard to comparative merit or professional advance in the individual. It would deprive the new engineers of that *esprit du corps* due to a military training and honorable traditions, and lead the young aspirant to believe that all he has to do is to *get in*, and a position worth $6,000 per year is his in the natural course of events, without special personal effort.

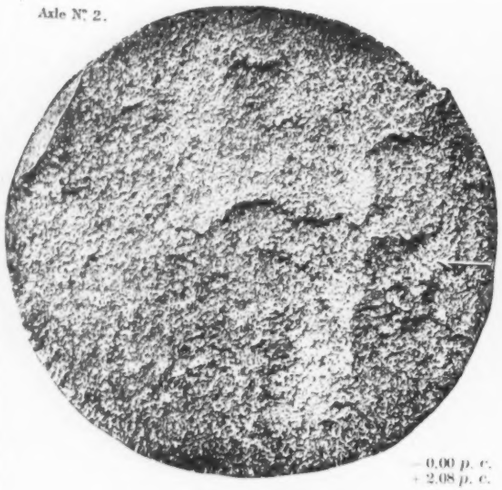
What the proposed bill particularly lacks is a spur to the individual, one that will either push him steadily and rapidly forward, or prick him so sorely that he will get out of the way of more deserving men. No cast-iron rule of promotion will do among engineers, if the services of the best among them are to be secured and retained, and no proper reorganization of the engineering service will bound their professional advance by the date of a commission. This is in fact, though in another form, the very thing now bitterly complained of by the civil engineers in the Government employ; they say truly that their engineering knowledge and experience weighs as nothing against a West Point diploma. But under the new organization any plodding engineer who gets in ahead remains forever ahead of the best man in the corps, regardless as before of individual merit.

The public works of our Government should command and retain the services of our ablest engineers, whether these come from the Army or civil life. There should be no class monopoly, and individual merit alone should decide the relative standing of the engineers without regard to a date on a commission. The waiting policy objected to in this bill will neither attract into the service the young, ambitious and hard-working engineer, nor will it retain in its ranks the good man developed by his

PHOTOGRAPHIC REPRODUCTIONS, SHOWING THE EFFECT

As determined in tests by THOMAS ANDREWS

Axle N° 2.



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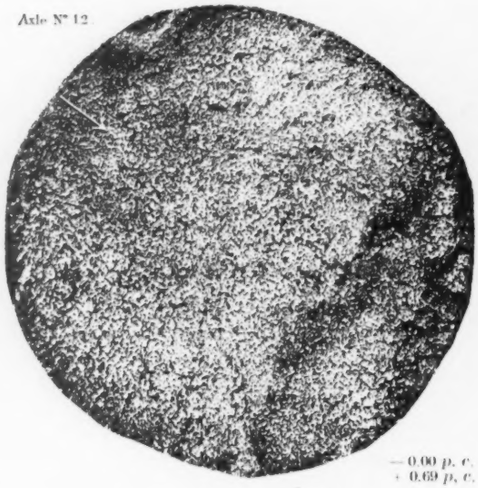

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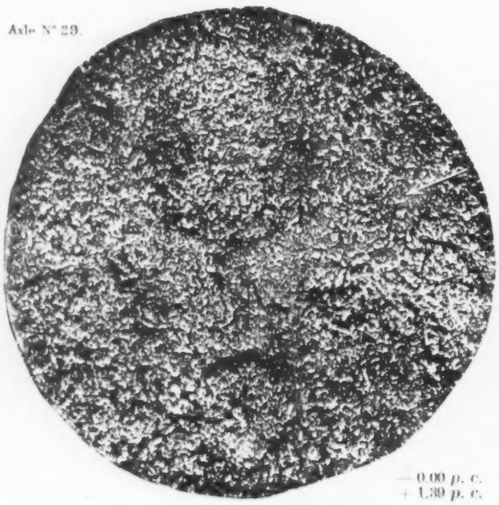

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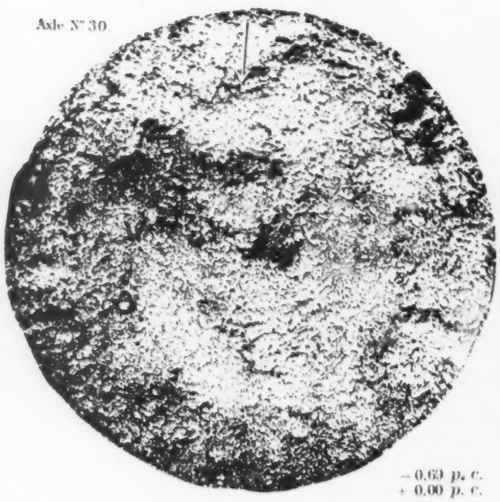

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COLD TESTS: 7° Fahr.

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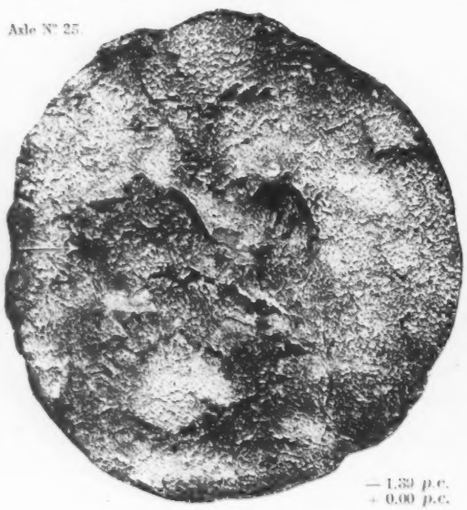

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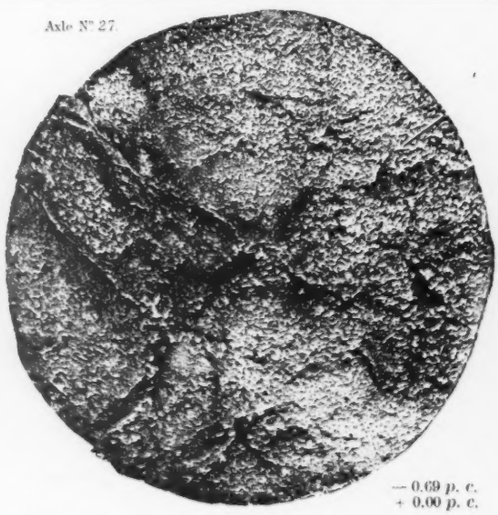

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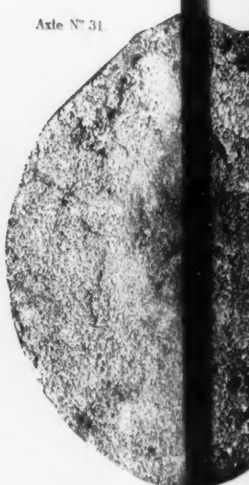

WARM TESTS: 100° Fahr.

The arrows indicate the direction of the destructive force.

TEMPERATURE ON THE STRENGTH OF RAILWAY AXLES.

...c. M. Inst. C. E. *Reduced One-Fourth from Full Size.*

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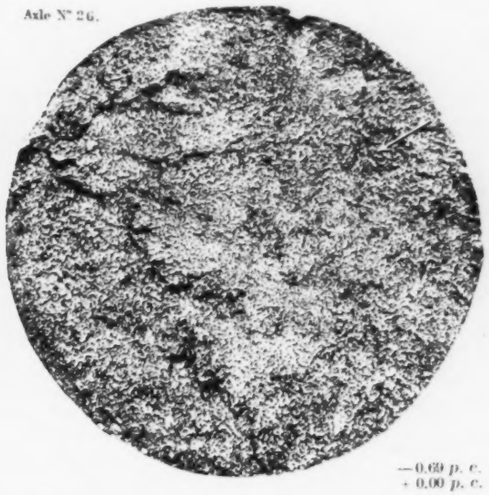

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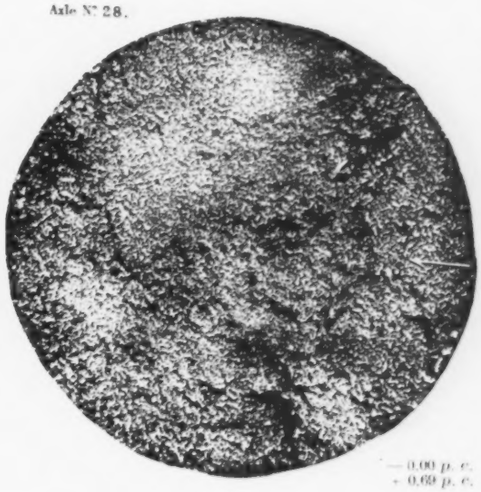

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COLD TESTS: 7° Fahr.

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Axle N° 5.

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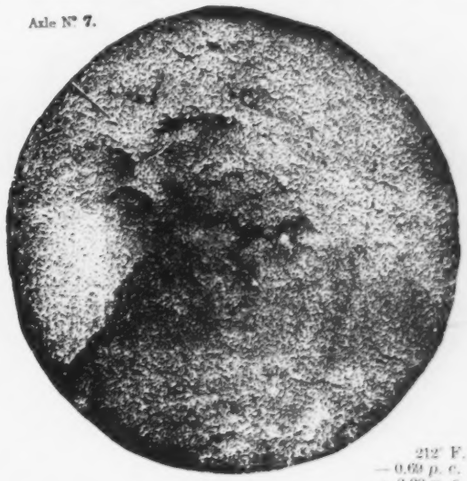

212° F.
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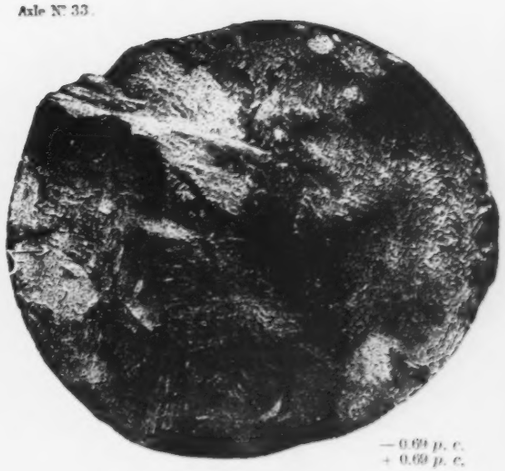
Axle N° 33.



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WARM TESTS: 100° Fahr.

The + and — percentages indicate the amount of resulting distortion of diameter from the blows.

service with the Government. Both classes can do better outside in reputation and material prospects. The result to be expected would be the gradual sifting out of the best material in the corps, and the residuum of patient, unambitious fellows remaining would not particularly advance the interests of the Government. It might be said that this same argument would apply to the Army organization, but it must be remembered that there is a certain intangible but attractive something about the profession of arms, even in times of peace, that is lacking in that of engineering alone; and while many good army engineers give their best endeavors to the service to the end of their useful lives, others do pass out into civil life under the temptations of a broader field of employment and more lucrative returns for work.

What we really need is a new department at Washington, and not a new bureau in an old department, as this bill would propose. If a War Department is necessary as a part of our national organization, a department devoted to the vastly greater interests of peace is quite as essential. Let the War Department attend to the development of our defenses and the Navy Department to its ships, and both will have plenty to do in that direction; but we should have besides these a Department of Public Works which shall control all engineering and construction, which is of a civil as contrasted with a military character. Under this department should be placed all work connected with the improvement of our harbors and interior waterways, our public buildings of all kinds, including lighthouses, etc., and finally our coast, geodetic and geological surveys. Each distinct class of work could have its own bureau, but these bureaus should all work together as parts of one machine controlled in its general action by one executive head. The efficiency of any present well-organized bureau, would be enhanced rather than impaired by the fact of having to report to a single department which embraced all kindred bureaus, instead of having these bureaus reporting to several distinct departments, as is now the case. The change would be in the interest of harmony, and economy of administration. Such a department is the rule over Europe, and our neighbors, Canada and Mexico, have both found it an essential feature in their national organization. Our present mixed administration of public works has its origin in tradition founded upon a very limited amount of such work, and it is time that we made a change to some system more in accord with our modern conditions.

In the administration of such a department the engineer would have a very important part to play, and no pains should be spared to secure and retain the services of the best men the country can afford, no matter where they come from. Common discipline demands that the status of these engineers should be well defined and their responsibility fixed; their pay should be liberal and the man who has faithfully served the Government up to a certain period of his life should be well cared for in his old age. In all these features we heartily agree with the provisions of the bill presented by Mr. BRECKINRIDGE; the exceptions are made to the limited control of the new organization, the fact that it would be after all only another bureau, and last and greatest that a rigid system of promotion by seniority will not best serve the public interest when engineers are in question.

It is true that Mr. BRECKINRIDGE provides for the infusion of some new blood in the case of first and second assistant engineers; but when the new man is once in the corps he practically falls under the rule of seniority for further advance, and this rule is absolute above the grades mentioned. It is doubtless expedient to fill the position of department engineer and all grades above it by promotion from within the corps; for experience in department routine and familiarity with local and national requirements are essential features in the successful administration of the higher offices. But the chief engineer, or an executive board of the highest officers in the corps, should have some voice in selecting their subordinates when any vacancy below them is to be filled, and men worthy to fill these positions can certainly be trusted in such a choice. In the case of a vacancy in any department the engineer of that department might nominate to the chief engineer five or more of the most deserving men in the grade from which the promotion is to be made, and then decide by a competitive examination which of the five is to win; and for promotion in the higher grades the chief with his associate chiefs should recommend the men in their judgment best fitted for an advance. Some system of this kind, honestly carried out, would put the good men at the head of the corps and leave the laggards where they can do least harm; it would encourage and recompense faithful and intelligent service and attract the better material to the service.

So too, if any outside engineer of experience sought admission into the corps, provision should be made for him to forward to the chief, or executive board, a properly attested record of his experience and his claims for any position under that of department engineer; and if the record warrants it he might enter into full competition with the engineers of the corps for the special vacancy to be filled, and stand or fall by the result of his examination. While there is little doubt that under the system of selection above described the government engineer would very generally win the prize, the very fact of such outside competition being possible would have a wholesome effect in keeping every ambitious engineer up to the highest standard of merit and alive to the further fact that he must compete with engineers generally and not his corps alone for individual advance. The point we would make is that an engineer in the Government service must not be able to prevent a better man from taking his place by retreating behind a Chinese wall of promotion by seniority alone. With an amendment to this effect we would heartily approve of the bill discussed, as a good beginning in a great work of reform; but hopeless as it now appears, we still trust that our lawmakers may sometime see the wisdom of basing this reform on broader grounds, and completely remodelling all that pertains to our system of public works,

The Proposed Bureau of Harbors and Waterways.

A bill is now before the House of Representatives, presented by the Hon. CLIFTON R. BRECKINRIDGE on Jan. 16, which is intended to create, under the War Department, a Bureau of Harbors and Waterways; this bureau is to be officered by a corps known as the Corps of United States Civil Engineers. This bureau is to have charge of the design, construction and preservation of the harbors and waterways and all works intended as an aid to navigation.

The corps is to be officered as follows with the titles and salaries indicated.

Titles and maximum number.	*Salary per annum.*
1 Chief	$10,000
4 Associate Chiefs	7,500
9 to 11 Department Engineers	6,000
50 Division Engineers	4,000
100 First Assistant Engineers	2 700
200 Second " "	1,800
250 Cadets	1 000

Actual traveling expenses, under orders, are to be paid, and at the age of 65 years any officer may be retired from the corps with a pension of one half the rate of pay he was entitled to at the time of retirement.

All of these engineers, excepting the Cadets, shall be appointed by the President of the United States by and with the consent of the Senate. The Cadets are to be appointed by the Secretary of War upon examination by a duly constituted board. At the initial organization of the corps, the appointment of all other than Cadets will be made upon the recommendation of a special commission, made up of 3 Army Engineers, of rank not below that of Lieutenant Colonel, and 3 civil engineers, citizens of the United States and of high attainments in engineering. This commission is also to carefully prepare a system of rules and regulations for the government and guidance of the new corps of civil engineers.

After the establishment of the corps all rank below the grade of associate chief engineer is to be determined by date of commission, and all new appointments of Cadets are to be made with special reference to experience, capacity, training and fitness for the work assigned to this corps. All vacancies are to be filled from the next lower grades by promotion. It is provided, however, that one-third of the vacancies occurring in any one year in the grades of 1st. and 2nd. assistant engineers may be filled by engineers not formerly connected with the corps, but who shall first submit to such examination and tests as may be provided.

The first chief of the new corps is to be appointed from the present Army Engineer Corps, of not lower rank than colonel; one-half of the associate chiefs, one-half of the department engineers, one-half of the division engineers and 20 of the first assistant engineers may be also appointed from the present military engineers, but of rank not lower than a first lieutenant in the latter case, and captain, major and lieutenant-colonel in the succeeding grades. In the initial organization in each grade the engineers from the Army and from civil life shall take rank in alternate position in each grade, and promotions from any grade shall then be in order of seniority.

The Secretary of War is to divide the country into not less than nine nor more than eleven departments, as nearly equal as the drainage areas and topographical features will permit. Each such department is to be under a department engineer.

After this corps is in operation, no appropriation or allotment of money for a harbor or waterway work is to be expended unless it is sufficient to complete the work, or provisions have been made by law for its completion, in addition to current appropriation. This, however, does not apply to snagging or dredging operations continuous in their nature; to the care of the plant, etc.; or to the completion of a distinct section of the work which may be in itself beneficial to commerce to an extent sufficient to justify the completion of this part. No work can be done until a distinct and detailed plan is made for each part, with estimates of annual needs and of the cost of completion, and under approval of Congress. The bill provides for the general efficiency and responsibility of this corps, and an annual report from the department engineer upon the general commercial wants of his division. These department reports are to be considered by the advisory board in their broad and national relations, and it is to recommend to Congress what it considers as best tending towards the development of a complete and harmonious national system.

In lack of sufficient government employment, the bill provides for the temporary retirement on half-pay of the engineer officers, and permits them to accept outside work. Otherwise the officers of this corps cannot hold any other civil office, or engage in any civil or military occupation of a professional character.

CORRESPONDENCE.

Fiber Strains in Pins.

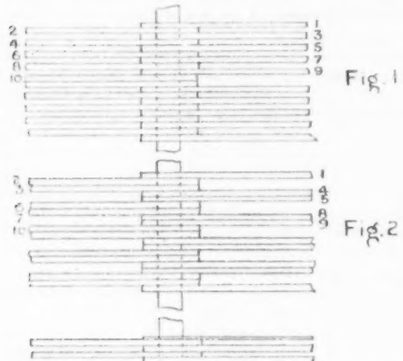
BLACK RIVER FALLS, Wis., Feb. 7, 1888.

EDITOR ENGINEERING NEWS:

Knowing Mr. JOHNSON'S discussion, in your issue of Jan. 28, to be contrary to good bridge practice and believing his theory to be at fault, I desire to express my views. While it is impossible to get the exact strain in pins, I think they can be gotten very closely, or as Mr. JOHNSON says, "as accurately as any other part of a bridge."

In Fig. 1, of the article referred to, the strain is

said to be five times the strain produced by the part 1 and 2, whereas it is customary to take the strains produced by these bars (or the two which carry the greatest strain in the pin. And I think this is not far from the truth. If bar 1 acts exclusively with 2, 3 with 4, 5 with 6, etc. then it would be correct to multiply by 5. But they do not act in that way. Bar 2 acts against 3 just as much as it does against 1, so also will 5 act against 4. Should this arrange



Diagrams of Chord Packing.

ment be continued until there were 500 bars on the same pin, it would not break, or even increase the strain in the least. And yet if Mr. JOHNSON's theory were true this pin would snap like a pipe stem.

In Fig. 2, the proper pin strain would be the strain carried by bar 2 and 3 multiplied by distance of their center from the center of bars 4 and 5. Instead of being a better arrangement than shown in Fig. 1, it is not half as good because the strain will be twice as great. Fig. 3 is the best arrangement.

If Mr. JOHNSON'S theory were correct for a continuous load, it would be wrong for a single panel load. Supposing, in Fig. 1, that the strain only comes in the bars on the right hand side, as will be the case when the engine approaches this panel point. Then his arrangement of couples will certainly be broken up, and bar 1 and 3 act against 2, 3 and 5 against 4. But this will not make any greater or less strain in the pin than a continuous load, at least I do not see how it can.

The arrangement shown in Fig 4. is bad and not at all necessary, because one end of a 16 ft. bar can be placed 3 ins. in or out of a straight line joining the other end if necessary; and this is often done. While these examples of chord packing are good enough to illustrate principles by, none of them are practical, because in no case is it possible to place them as shown on account of diagonal floor-beam hangers and post connections.

A. S. COOPER.

[We reproduce the cuts referred to from our issue of Jan. 28, and leave Mr. JOHNSON to fight his own battles.—ED. ENG. NEWS.]

Titles of Engineers.

DENVER, Col., Feb. 1, 1888.

EDITOR ENGINEERING NEWS:

As a sequel to your editorial in issue of Jan. 25, allow me to submit the following ideas on titles of engineers.

I approve of your recommendations for Chief Assistant, Chief Division and Resident Engineers, and suggest the following:

Engineer in Charge.—An engineer conducting a preliminary or locating survey as chief of party on all surveys of importance or where the position is of such responsibility as to call for an engineer of ability, equal to a Division or Assistant Chief Engineer. Where the work is retracing a line previously located, or where it is a final location over ground where many surveys have been made and location at all points is settled by a Chief Engineer or other superior, making the position of less responsibility and calling for less judgment, or where the necessities of the case require that the survey be placed under an untried or incompetent man and the general oversight given to some Division Engineer or taken by the Chief, would substitute the following title:

Assistant Engineer.—An engineer, such by training and abilities, who may be assigned to such miscellaneous duties as giving centers and grades for track laying, giving centers and elevations minor bridges, trestles, etc., running land lines and, in fact, any miscellaneous work, and as a title for addresses of communications only to such engineers as may be assigned to duty as transitman, levelman, levelman taking cross-sections and topographer in locating parties.

I would not like to see the title "Assistant Engineer" applied as you propose, or as I understand your proposition. Where there is an instrument man on construction the title of levelman or instrument man will usually be more appropriate. The man is as a rule a novice, and while his abilities may, and should be such as will make an engineer, he is not one now.

I like the system in vogue in the U. S. Engineering Department, where the title of Assistant Engineer (the only engineer title usually given) is given only to those who may be in positions of responsible charge as engineer. A man may be Superintendent, Overseer, Transitman or Levelman, but he is not called Assistant Engineer unless his position is such as to call for that title.

I shall hail with joy any step, toward an adjustment of titles, and would like to make it a move toward elevating the title of "Engineer" to its proper place.

A. M. VAN AUKEN.

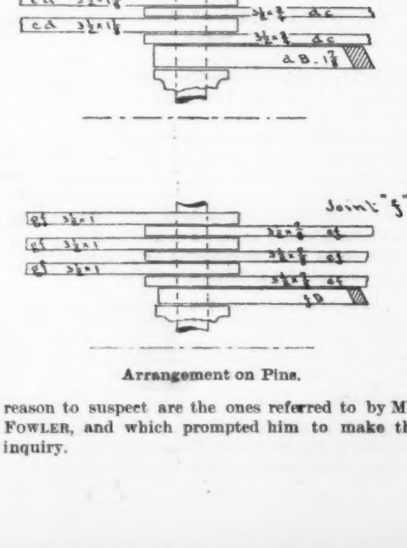
[Too much refinement in such matters should not be attempted nor hoped for. The general rule that "Assistant Engineer" should in no case imply responsible charge of work, but that either "Principal Assistant," "Division" or "Resident" Engineer should be used instead, seems to us a good one. "Assistant" means anything or nothing, and always will; perhaps for that reason it will continue to be preferred in many cases, as on the U. S. Engineer Corps. ED. ENG. NEWS.]

Bearing on Pins.

PITTSBURG, Pa., Feb. 1, 1888.

EDITOR ENGINEERING NEWS:

Referring to the question of bearing on pins, broached by Mr. C. E. FOWLER and discussed by Prof. JOHNSON in your issue, of Feb. 4, I beg to submit my figures for two actual cases, which I have some



Arrangement on Pins.

reason to suspect are the ones referred to by Mr. FOWLER, and which prompted him to make the inquiry.

These pins were located in a combination bridge which the writer had occasion to examine and report upon a short time ago, and I think Prof. JOHNSON will agree with me that the arrangement of bars in both cases is far from the best.

The strains on the bars are those due to an assumed live load of 3,000 lbs. per foot of bridge, which is very nearly equivalent to the one Mogul engine followed by 3,000 lbs. which several times daily traversed the bridge. No allowance whatever was made for impact.

The method depends simply on the ordinary theory of flexure and assumes, as generally prescribed in specifications, the force on each bar concentrated at the middle of the bearing. The distances between the applied forces are assumed one-sixteenth inch more than the sum of the half thicknesses of the bars.

	Strain.	Shear.	Lever.	Moment.	
ed	+ 45575	+ 45575	1"	+ 45575	
dc	− 30250	+ 15325	1"	+ 15325	+ 45575
ed	+ 45575	+ 60900	1"	+ 60900	+ 60900
dc	− 30250	+ 30650	1 5/16"	+ 42140	+ 121800
dB	− 30650	0			+ 163940

163940 ÷ 1.53 = 107,000 lbs. per sq. in.

gf	+ 40583	+ 40583	1"	+ 40583	
ef	− 37016	+ 3567	1"	+ 3567	+ 40583
gf	+ 40583	+ 44150	1"	+ 44150	+ 44150
ef	− 37016	+ 7134	1"	+ 7134	+ 88300
gf	+ 40583	+ 47717	1"	+ 47717	+ 95434
ef	− 37016	+ 10701	1 1/16"	+ 12710	+ 143151
fD	− 10701	0			+ 155861

155861 ÷ 1.53 = 102,000 lbs. per sq. in.

The first column contains the strain on each member, and the next one towards the center, the second the shear between each member, the third column, the lever arms, and the fifth, the bending moments at each point of application.

The method has an advantage over the usual graphic process in conciseness and accuracy, and when a slide rule is used, has the advantage in speed as well.

The calculations show only the horizontal bending, but the vertical bending should be obtained in a similar manner, and the two combined before obtaining the strain per square inch. The vertical is not, however, needed in the present case to prove a bad state of affairs.

The constant 1.53 by which the bending moment is divided to obtain the strain per square inch, is taken from a table made for this purpose, and is equal to $\frac{n\,d^3}{32}$, d being the diameter of the pin; in this case 2 1/2 ins.

Yours truly,

FRANK C. OSBORN,

PERSONAL.

THOMAS SHANAHAN, railroad contractor, of Portland, Me., died at that city recently.

ASHBEL W. BARBER, C. E., a member of the Southern Society Civil Engineers, died in January at Pennington, N. J.

GARRET WALKER, son of Hon. ALEX. WALKER, died on Feb. 7 at Pass Christian, La. The New Orleans *Times Democrat* refers to him as a distinguished civil engineer.

D. MCCOOL, General Manager of the St. Josept & Grand Island Ry., has resigned to accept the position of General Manager of the California system of the Atchison, Topeka & Santa Fé Ry.

Col. R. E. RICKER, recently General Superintendent and Chief Engineer of the Denver & Rio Grande Ry., will succeed JOSEPH HERRIN as Assistant General Superintendent of the Missouri Pacific Ry.

W. H. SELBY, Superintendent of Motive Power and Machinery on the St. Louis, Arkansas & Texas Ry., has been appointed Superintendent of Motive Power, Machinery and Rolling Stock on the Chicago & Atlantic Ry., with office at Huntington, Ind.

Col. A. A. GADDIS, Vice President of the Brunswick & Western Ry., has resigned his position and accepted that of General Manager and Purchasing Agent of the Atlantic & Pacific Ry.

Gen. THOS. L. ROSSER has been appointed Consulting Engineer of the Charleston, Cincinnati & Columbus R. R., and the Chief Engineer has notified all the locating engineers north of Marion, McDowell county, N. C., that Gen. ROSSER will be in immediate charge of the work.

RUDOLPH HERING addressed the Board of Trade, of Columbus, O., on Jan. 13, on the sewerage

problem of that city. His address was in the form of general advice only, as he had not made a special study of the situation in that city.

F. W. IREDELL, Mining Engineer, formerly of Isabella Furnace, Chester Co., Pa., and of Philadelphia & Reading Coal & Iron Co., now of this city, has removed his office as purchasing agent for machinery and contractors' supplies to 10 Park Place, where he should hereafter be addressed.

The Business Outlook.

The most hopeful feature in the financial world since the new year came in has been the unusually active market for railway bonds. It is stated that within the last six weeks the total of bond issues taken by New York and Boston banking houses amounts to about $70,000,000. It is a noticeable fact that practically the whole of this capital has been secured by the great systems like the Santa Fé, the Manitoba, the Illinois Central and others. It is doubtless true that this active bond market is a healthy and legitimate result of last year's general prosperity. The general public is seeking to invest its savings in the safest and staunchest securities in the market at low rates of interest, and at a premium in preference to bonds or stocks of less stable companies which are offered in great abundance at low prices. All these things indicate a conservative and sound sentiment among investors which, while it does not create the feverish activity of a speculative boom, is productive of a healthy prosperity among all classes which is thoroughly gratifying.

Probably from two-thirds to three-fourths of this $70,000,000 (and if the demand keeps up for a few weeks longer this sum will be largely increased), has been borrowed by the companies, not to pay debts but to spend for betterments in rolling stock and permanent way and in building new extensions. That railway building for the present year is to fall flat is a prediction which is not warranted by facts. The new mileage for the present year may indeed fall below the 12,000 odd miles built in 1887, and it is perhaps better for the country as a whole that it should. Locking up too large an amount of the available capital of the country in investments which in many cases will not prove remunerative for some years, is very likely to cause a dangerous stringency in the money market. Nevertheless out of the enormous number of lines projected in the different parts of the country there are very many which have such a backing and such prospects of profitable traffic that their construction is reasonably sure. It goes without saying that the most of this work will be done upon extensions of the great systems. Independent railroad corporations have had their day.

The rivalry between the different systems in the Northwest and Southwest does not permit one company to stand still while its rivals are building branches and extensions to develop traffic, and with the new territory still to be opened up in which the first comer gains a certain permanent advantage over future competitors, there is every probability that the great areas in the far western territories and the South still undeveloped will be given railroad communication at an early date.

Probably the most uncertain and disturbing element to be taken into account in examining commercial probabilities is the Western rate war. The storm has been slowly gathering for a long time and the building of new competing lines, bound to advertise their opening by a fierce attack on existing rates; the growth of some personal feeling perhaps between the managers of the different systems; and the harassing influence of State rate fixing commissions, have all combined with other favoring circumstances to bring on a war in rates which is without a parallel in the business affected. What its outcome will be it is not easy to say. Many predict that there will be no treaty of peace until the law of the survival of the fittest comes into play.

The absurd position so often taken by State railroad commissions and thinking men who are unacquainted with railway management that the volume of business is affected very much by a lowering of rates is fully proven by the fact that the whole volume of traffic has not increased very much although rates have fallen off in some cases *two-thirds* or more.

Of course running expenses at best cannot be decreased, and knowing the proportion of former traffic receipts to expenses it is plain that when the first fall off from 50 to 60 per cent., every day of business brings a certain cash loss. The question is thus resolved merely to one of endurance, and the road which staves off bankruptcy the longest will absorb its rivals. Mr. GEO. M. PULLMAN, is reported to consider this as the probable outcome of the war, but there is certainly ground for a difference of opinion and belief that the managers will reconcile their differences and agree to work in harmony before this end is reached.

Besides this most prominent factor in the industrial problem, there are many of doubtful value. The reports from abroad are alternately warlike and peaceful; The tariff agitation is certainly conducive of uneasiness and uncertainty; the growing tendency of State and National legislatures to assume the guardianship of corporate business is equally to be desired and feared; and with unknown strikes, uncounted Trusts for limiting production, and Socialism, Anarchy and other disrupting ideas spreading and bearing fruit, there is certainly enough to make a pessimist deliriously happy.

No one is obliged to be a pessimist, however. There is wealth enough, resources enough, and good sense enough in this country to give us another year of prosperity. The real estate fever ought to abate; the railroad promoters with great expectations and few dollars ought to content themselves with a preliminary survey, but that a healthy growth and legitimate activity in all classes of business may reasonably be expected during 1888, must certainly be the honest conclusion of thinking men.

List of Errata.

In the *second* revised and enlarged edition of the "Economic Theory of the Location of Railways" (as also in the *first*) corrected in the *third* revised edition. List of errata in the first revised edition, corrected in the second (published in ENGINEERING NEWS, Oct. 1, 1887), will be sent to any address on application. Those who may detect any further typographical errors are requested to send list to this office for correction in the fourth edition.

PAGE.

38—6th col. of Table, *for* 934, *read* 93.4.

40—Table, *for* "Total, 4 years" *read* "5 years."

41—First table, under "no dividends" erase column of ditto (") marks.

42—For "DESCRIPTION OF GROUPS, TABLE 5" *read* Table 6.

45—Heading to Table 10, *to read* "Mileage, Cost, etc. of" European Rys. *in place of* "Mileage of American and" etc.

52—Last line but one of par. 43, *for* "shold" *read* "should."

106—5th line, *for* (Chap. II.) *read* (Chap. III.)

111—1st Col. of Table, *for* 93.4 *read* 92.4.

132—2d line under table, *for* 108.61 × 12.4 = *read* 108.61 × 1.124 =; and next line, *for* 122.3 or 22.3 per cent. *read* 1.221 or 22.1.

151—last line, *for* "J" *read* "I."

179—2d. col. of Table *read* "YARDS and STRUCTURES, 8.0 p. c." in place of 8.5 p. c.

232—Table 98; letter *T* gone.

234—Last line but one of par. 227, *for* created *read* credited.

276—end par. 280, *for* XIX *read* XXX.

286—par. 302, end of par. (3), insert decimal point before 00087, to *read* .00087. Same correction in formula just below.

288—par. 305, 1st. line, *for* follow *read* follow, and *for* shippage *read* slippage.

289—Table 111, last line, 3d and 4th cols. *for* .72 *read* .54 in 3.1 col. and *for* 1.44 *read* 1.08 in 4th col. 1st line after table, *for* Table 110 *read* 109.

320—3d line of 2d. par., *for* 5⅝ lbs. per degree of, *read* 5¾ lbs. per mile of.

326—1st line of 6th par., bridge-builders spelt wrong. *d* left out.

334—3d line of par. 375, *for* radius of gyration *read* centre of gyration, and *for* radius at which, *read* point at which.

349—last line par. 401, *for* (Table 18) *read* (Table 118).

357—2d line under table, *for* 100 *read* 10·0.

379—1st par. of par. 456, next to last line, *for* (Table 123) *read* (Table 124.)

386—2d line of 2d par. of par. 470, *for* 0·0.25 *read* 0·025, *i. e.*, take out second decimal point.

389—under "Fig. 94." 6th line, *for* 101.8 *read* 100.9, under "Additions," 1st. line, *for*—0.75 *read* —0.35.

396—Correct tabular matter to read as follows:

	$2,665.00	$26,650.00
	(2d., 3d. and 4th. lines as now.)	
Totals	$17,935.00	$179,350.00

3d. line below, *for* $2,219,500 or $11,097 *read* $2,562,000 or $12,810.

10th. line par. 477, *for* $155,365 *read* $179,350.

513—10th. line. *For* theut most *read* the utmost.

538—Equation (2) *for* $\frac{h^2}{d} + d$ *read* $\frac{h^2}{2d} + d$.

554—2d. line of 4th. par., take out comma after considered.

587—5th col. of table, *for* 195,000 *read* 193,200.

605—last line of 1st part of table, *for* 105 *read* 1.05.

642—3d line from bottom *for* TANGENT: *read* TANGENTS:

643—end of 5th complete line, *for* $\frac{1}{D}$, *read* $\frac{1}{D}$. next line, *for* (2 T − L) *read* (2 T − 1).

666—Cut is battered, or badly printed.

714—last line of second col. add asterisk after 1,393.* *add* * Actual population, 1885, 1,439,037.

741—2d line under table, *for* 11.7 *read* $\frac{11}{7}$.

757—2d col. of table, *for* 61.1 *read* 6.1.

781—8th line of par. 1052, first word, *for* turning *read* burning.

820—end 6th line, *for* ton *read* cwt.

833—5th line of par. 1131 *for* file *read* fill.

841—3d line of 3d par, *for* above Fort Benton *read* below.

854—end of 1st par., *for* Fig. 292 *read* 277.

865—4th line from end par. 1188, *insert* is *to read* As it *is* always.

884—5th line, *for* semicolon *substitute* a comma.

888—end 1st par. of 1243, *for* Fig. 208, *read* 298.

901—3d line of 2d par. of 1272, *for* weights *read* heights.

PUBLICATIONS RECEIVED.

FRANKLIN LEONARD POPE, an authority in electrical affairs, will contribute to the March number of *Scribner's Magazine* a paper on the "Electric Motor and its Applications," which is a complete account in brief compass of the origin and development of the use of electricity as a motive power. It will be fully illustrated.

Engineering News Catalogue of Publications.—We have just received copies of our new 70 page catalogue which contains a long list of works of professional and general interest, including text books and industrial works for colleges, polytechnic institutes, engineers, architects, etc.; also miscellaneous publications. There is an index of authors and their works, as well as a general index. We shall be pleased to send copies of this catalogue on application.

The Lithographer's and Photographers' Directory, published by *The Lithographer Publishing Co.*, at 12 Center street, New York, is on our table. This directory is the only work of its kind published in the United States, Canada or South America, and was prepared only after overcoming many difficulties and at vast expense, because no work of a similar sort had ever been undertaken in this country before. The directory is ably edited by FRED. BUEHRING, an authority in two continents on matters pertaining to the art of SENEFELDER, and contains a complete list, with the latest procurable addresses, of all firms connected in any respect with Lithography, Photography, or the graphic arts or allied trades. Special attention has been devoted to Photography, so closely allied to Lithography, and the list of American photographers is the most complete and latest in existence. All manufacturing firms and supply houses engaged in lithography, photography and the allied arts and trades have been inserted; also a brief history and bibliography of lithography and the development of photography. This directory must of necessity be of the utmost value to the important trade it represents. Copies of the directory can be obtained from the publishers; price $3.

Standards of Length and their Practical Application.—A Resumé covering the methods employed for the production of standard gauges, to insure uniformity and interchangeability in every department of manufactures, including reports of Prof. W. A. ROGERS and others. Edited by GEORGE M. BOND, M. E. The Pratt & Whitney company, Hartford, Conn. 8 vo., 180 pp. 30 cuts, numerous tables.

It is seldom indeed that one sees a "trade publication," as we suppose this must be technically classed, containing such an amount of valuable technical information, nor recording such important contributions to the cause of exact science on the part of a single private firm, as is recorded in this volume, which is an exhaustive scientific treatise on its subject matter. The rule heretofore has been that such work, when, done at all, has been done under governmental supervision, and at the public expense. It speaks well both for the firm and the country that such work should here be done otherwise, when it can be done so well. We shall hope to notice the contents of the volume more fully at a later date.

THE Lackawanna Steel Works, with orders ahead for 30,000 tons of steel rails, declines to take any more orders for the present. The price now is $31.50 per ton.

A REPRESENTATIVE of the Panama Canal Co. has lately secured the services of an engineer and assistant at $400 and $250 per month and expenses, to survey a large tract of land contiguous to the canal in the U. S. of Columbia.

It is proposed to follow the United States land system of division, with the addition of a topographic map, and thus presumably aid the canal by the sale of land.

Maj. O. H. ERNST, U. S. Engineers, reports to the Secretary of War that in his judgment any improvement at the mouth of the Brazos river, Texas, making an entrance suitable for a naval station or harbor of refuge would be impracticable. The attempt would be both costly and a doubtful experiment. The work already done has disappeared without having any effect on the bar.

The Weather of the United States for the Month of January, 1888.

[As respects the elements of most interest to engineers.]
According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	Temperature. Degrees Fah.				Wind Velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average	Max.	Direction. Max.	Total.	Hardest in 24 hours.	No. rainy days.
Northern Cities.										
Northfield, Vt	7.1	41.4	−24.1	65.5	11.1	51	N	4.99	1.81	19
Portland, Me	14.3	46 7	−12.3	59.0	7.5	36	S & N	6.65	1.93	14
New York City	25.9	54.2	1.9	52.3	13.7	60	W	5.14	1.58	14
Pittsburg, Pa	28.6	61.0	3.0	58.0	8.2	36	NW	6.17	1.21	22
Chicago, Ill	15.1	43.6	−16.8	60.4	11.1	37	SW	1.56	0.51	12
Omaha, Neb	8.0	51.3	−25.2	76.5	8.2	42	NW	0.58	0.34	4
St. Paul, Minn	−0.9	34	−41.2	75.2	4.9	25	SE & NW	0.72	0.34	10
Duluth, Minn	2.1	37	−34	71.0	6.4	29	W	1.53	0.52	11
Bismarck, Dak	5.3	40	−37	77.0	7.8	54	NW	0.96	0.36	10
Average	12.78	45.5	−20.5	66.1	8.8	41		3.08	0.96	13
Southern Cities.										
Washington City	29.0	54	9	45	4.5	30	NW	2.99	0.85	10
Louisville, Ky	32.3	69	7.9	61.1	9.3	28	W	3.26	1.18	13
St. Louis, Mo	24.3	67.8	−11.5	79.3	11.5	52	SW	2.15	0.73	9
Savannah, Ga	52.5	76	27.2	48.8	6.8	28	NE	2.09	1.26	9
Leavenworth, Kan	16.3	54.9	−21.1	76.0	6.5	30	NW	0.93	0.39	5
Jacksonville, Fla	57.2	80.7	27.8	52.9	5.9	26	NW	0.49	0.20	11
Chattanooga, Tenn	42.1	73	13.2	59.8	6.4	26	NW	6.79	2.18	16
New Orleans, La	55.6	79.6	28.8	50.8	7.6	30	N & S	3.29	1.64	13
Memphis, Tenn	38.2	74.5	6.2	68.3	7.7	36	NW	4.04	1.17	13
Palestine, Tex	43.4	77.7	3.7	74.0	9.3	38	S	4.50	1 60	17
Average	39.09	70.72	9.12	61.6	7.6	32.4		3.05	1.12	11.6
Far Western Cities.										
Helena, Mont	5.3	56.5	−41.0	97.5	4.0	48	W	0.79	0.43	10
Fort Angeles, W. T	Reports not received.									
San Francisco, Cal	46.3	62.8	28.7	34.1	7.1	40	NW	6.81	1.58	16
Salt Lake City, U	23.2	52.8	−16.7	69.5	5.1	40	S	1.52	0 62	8
Denver, Col	27.3	76	−20.3	96.3	7.9	60	NW	0.11	0.06	4
Yuma, Ariz	51.6	78.6	27	51.6	7.8	32	N	0.18	0.18	2
Santa Fè, N. M	30.3	59.5	−2	61.5	6.6	30	N & SW	0.44	0.20	6
Average	30.7	64.4	−4	68.4	6.4	42		1.64	0.51	8

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular meeting was held Feb. 15, Vice-President J. J. R. CROES in the chair. A paper by GRATZ MORDECAI, Assoc. Am. Soc. C. E., on "The Classification of Railroad Accounts and the Analysis of Railroad Rates," was read. Mr. IVES, a visitor, exhibited and explained a new form of geological relief maps, invented by himself. There are as many sheets of different colored cardboard as there are formations represented, and from each card is cut away every part outside the outline of the formation represented; when these cards are superimposed a map is formed showing the various strata in their proper position. Mr. T. C. CLARKE explained the condition of the ceiling of the Assembly chamber at the capitol, Albany, N. Y. Not only is this ceiling in as dangerous a state as reported, but the whole building is cracked in several places. He remarked that the settlement of the foundations, which were put in by an engineer, is practically *nil*, although they had not been intended to support the enormous weight that has been put upon them. The subject was discussed, and remarks made on the effect of the iron tie-rods in the roof of the chamber and also on the settlement of the large business buildings in New York City.

Engineers' Club of Philadelphia.—Record of business meeting, Feb. 4. Past President L. M. HAUPT in the chair; 19 members present; Prof. L. M. HAUPT, of the Committee representing the Club, submitted, with comments and explanations, and other data, House Bill No. 4923, "To regulate certain expenditures in the War Department and for other purposes"—relative to the establishment of a Bureau of Harbors and Waterways, to be officered by a corps to be known as the Corps of U. S. Civil Engineers.

The Secretary presented, for Mr. RUDOLPH HERING, the following preamble and resolution which had been passed by the American Society of Civil Engineers, which, after some discussion, with the substitution of the name of the Club, were adopted.

Whereas, it is deemed highly desirable by the engineering profession that better information should be collected than is now available regarding the intensity of rainfalls in different sections of the United States, particularly with reference to the practical questions involved in the construction of works for water supply and sewerage, and

Whereas, it is entirely feasible for the Signal Service Bureau to obtain such information without increase of force, but simply by the erection of automatic, self-registering rain gauges in addition to those now employed; therefore,

Be it Resolved, That the Engineers' Club of Philadelphia respectfully urges upon Congress the desirability of inserting in the next annual appropriation bill for the Signal Service Bureau an item sufficient to cover the expense of placing automatic rain gauges at all principal stations, as the Chief Signal Officer may direct.

Mr. A. MARICHAL read a paper on "Rainfall," calling the attention of the Club to the importance of continuous and detailed observations. The rainfall is one of the most capricious of phenomena, and unless our observations be very numerous and complete in detail, it is impossible to make any useful deductions. The tables and diagrams required are numerous, including the rainfall all over a given country, per day, per month, per year, with corresponding height of barometer, temperature and direction of wind; the rainfall compared with the stream flow; the rainfall compared with the sanitary condition of cities and towns; in the case of an epidemic, the rainfall compared with the progress of the disease; and the rainfall compared with the age of the moon; etc.

Mr. MARICHAL presented, also, diagrams showing the mean annual rainfalls over the world, ranging from 527 ins. (Rhasia Hills, India) to 0 (Sahara, Africa and coast of Peru), and showing that the localities where an enormous rainfall was recorded were as unhealthy as those where only 15 ins. and less was falling annually; that, generally, the death rate was a minimum where the rainfall was about 35 to 45 ins., as in Philadelphia, which is among the healthiest cities in the world; that the maximum rainfall was near full moon, and the minimum near new moon; that a 28 years' experiment in France, and a 20 years' one in Germany, gave practically the same results.

A series of resolutions relative to the publication of papers were presented by Mr. J. E. CODMAN and others; a letter offering amendment to the same was presented from Mr. CHARLES G. DARRACH; there was a lengthy discussion and many suggestions were offered.

Engineers' Club of St. Louis.—The club met on Feb. 1, at Washington University, President HOLMAN in the chair, 35 members and 2 visitors present. The committee appointed at last meeting to report to the club suitable action on J. A. L. WADDELL's efforts to reform the present practice in the building of highway bridges reported as follows:

TO THE ENGINEERS' CLUB OF ST. LOUIS:

Your committee appointed to consider what action should be taken on Mr. WADDELL's invitation to endorse him in his efforts to raise the standard of the highway bridge practice in this country, beg leave to report as follows;

Resolved, That this club express their approval of the pamphlet entitled "General Specifications for Highway Bridges of Iron and Steel," by J. A. L. WADDELL, and deem it a well considered effort to bring about a much needed reform.

That we recommend these specifications to the consideration of county and town boards as calculated to give structures both safe and economical when faithfully carried out, but that to insure these results competent engineering supervision is absolutely necessary.

That in the letting of highway bridge contracts and in the acceptance of the finished structures such boards should, in all cases, call to their aid a competent Civil Engineer, and thus insure at once the public safety and the wise expenditure of the public funds.

J. B. JOHNSON, ROBT. MOORE, N. W. EAYRS,
Committee.

The report was laid on the table with notice that it would be called up in two weeks.

The following resolution was moved by R. E. MCMATH:

Whereas, The United States Signal Service, without increase in force or expense, if equipped with suitable instruments, can make observations of the rate and duration of rainfall, and thereby furnish information of great scientific value, and of the utmost practical importance in the solution of questions of water supply and drainage of cities; therefore,

Resolved, That the Engineers' Club of St. Louis fully endorse the suggestion recently made by the Chief of Signal Service that self-registering rain gauges be provided at all observation stations; also,

Resolved, That we request the committees of the two Houses of Congress to insert in the next appropriation bill an item to cover the cost of such instruments.

This resolution was unanimously adopted. CARL GAYLER then read a paper on "Highway Bridge Floors," giving several standard designs, with their weights and cost. B. F. CROW read a paper on "Constructive Accounts," showing how the cost of the material and labor required to produce each integral part of a street car is found, by means of labor and material accounts with all the orders. One man does all the work due to this system of accounts for 150 workmen. Blank forms were shown and the method described in detail. After a general discussion of this paper the club adjourned.

Southern Society Civil Engineers.—The 13th regular meeting was held recently at Jacksonville, Fla. Discussions on drainage and land reclamation followed the regular order of business. The membership of the Society is rapidly increasing. The admission fee is $5 for all classes; the annual dues are $5 for seniors, and $3 for juniors. The following were elected officers for 1888: President, H. S. DUVAL, State Engineer of Florida; Vice-Presidents, LOUIS J. BARBOT, City Engineer Charleston, S. C., J. E. BOZEMAN, M. L. LYNCH, J. G. MANN and T. R. DUNN; Treasurer, J. W. BUSHNELL Chief Engineer, Florida Railway & Navigation Co.; Secretary, T. S. MOORHEAD, Jacksonville, Fla.; Directors, R. N. ELLIS, C. F. SMITH, J. G. GIBBS, P. W. O. KOERNER and A. BAUER; Committee on National Public Works, LOUIS J. BARBOT, N. E. FARBELL and T. S. MOORHEAD.

New England Water-Works Association.—An adjourned meeting of the New England Water-Works Association, was held at Boston, on Wednesday, Feb. 15, 1888, at which 65 members were present. After a substantial lunch, the President, EDWIN DARLING, called the meeting to order, and the following persons severally elected;

Active:

J. W. RINGROSE, Sec'y Water Commissioners, New Britain, Conn; GEORGE A. ALEXANDER, President Water Supply Co., Bath, Maine; RICHARD A. HALE, Principal Ass't Engineer, Essex Water Power Co., Lawrence, Mass.; GEO. E. EVANS, City Engineer, Lowell, Mass.

Associates.

FRANK B. DURFEY, Norwich, Conn.; J. HENRY WELLS, Boston.

In consideration of his long and faithful service in connection with the Water Department of the city of Boston, Mr. E. R. JONES was elected an Honorary Member.

The President announced the topic assigned for discussion to be, "Water Waste, with Especial Reference to the Amount Used During the Winter Months, to Prevent Freezing." Commissioner HAWES, of Fall River, said they had 400 frozen services at the present time, but were not using as much water as one year ago. The consumption had steadily decreased for several years in spite of the large increase of new takers, and was, perhaps, attributable to the use of meters whereby the department was paid for all water whether used or wasted. They had no trouble with freezing of meters if set according to requirements.

Asst. Engr. DEXTER BRACKETT, of the Boston Department said that during three or four of the coldest days of the present winter, the daily consumption of water had increased to 70,000,000 galls., as against 35,000,000 galls. average daily consumption for the month of November, showing that one-half the water furnished was to meet the enormous waste due to the effort on the part of water takers to prevent freezing.

He cited figures from experiments made in 1881-2, showing the consumption in a section of the city having a population of 2860 persons using an average of 27½ galls. per capita on a day of ordinary temperature (Dec. 23) and on an excessively cold day (Jan. 24) 61 galls. per cap ta. During the nights above mentioned the figures increased from 9 galls. to 52 galls. per capita. Later in the month, the consumption increased from 27 galls. to 100 galls. per capita and the night rate was raised from 9 to 89 galls. The causes for the waste he attributed to poor plumbing and he had found no way to stop it but there was this consolation that it came at a season of the year when the water supply was usually abundant.

The loss of head from Mystic Reservoir to East Boston during the recent cold weather was about 63 ft., and from Chestnut Hill to the city about 35 ft., making a loss due to the extra waste of about 20 ft.

Supt. HYDE, of Newton, reported that their consumption had not been materially increased because of the general use of meters in that city.

Supt. KENT, of Woonsocket, R. I., was obliged to encourage waste in order to keep their pipes and hydrants open. He had found frost from 5 to 7 ft. deep, and in order to meet the increased demand for water had been obliged to run his pumps 16 hours a day as against six ordinarily.

Supt. COGGESHALL, of New Bedford, reported an increase much in excess of former years, although they had been troubled but little with freezing of services.

Supt. NEVONS, of Cambridge, did not want to stop waste, in fact, the Water Board, in 1875, had issued a notice asking people to allow the water to run to avoid freezing. They had several hundred feet of from 4 and 6-in. pipe frozen during the present winter—had not yet found a way to prevent waste.

Supt. DARLING, of Pawtucket, found that the use of meters protected his department against excessive waste; the season had been unusually severe, and frozen services had been numerous. He found that in the warm days the frost penetrated the ground more effectually than in the colder ones, and they had found it in places 6½ ft. below the surface.

Supt. JONES, of Boston, detailed the various attempts to prevent waste in the city as follows: 1st. Night inspection with a large force of men, and this had proved a failure. 2d. Fining every one detected in allowing water to run when not actually in use—this method raised serious difficulties and was abandoned. If waste must continue, he would advise large mains and let it run. The present season he thought less severe than in 1874-5, when he had 2,000 frozen services at one time. Men who knew how to thaw pipes were not numerous enough to supply the demand at that time, and the department was obliged, for the first time in its history, to issue permits to plumbers to dig up the streets. He favored, as the best method of thawing, the cutting of the service inside the cellar wall and putting in a ½-in. round-way cock and then using a ¾-in. block-tin pipe, 50 ft. in length, with funnel attached, into which hot water was poured, and as fast as the ice was thawed the pipe was pushed into the service. This had been found a very quick and satisfactory method if services were straight.

Supt. BILLINGS, of Taunton, reported an increase in pumping in his city, and gave a comparison between the hours from 6 P.M. to 6 A.M., for the month of November, as against some of the severer days of January, showing the increase to be from 176,000 galls. to 413,000 per night. He would like to stop waste, but knew of no method except the purchase of 1,000 or more meters, which in their present condition was not advisable.

Sec'y KNAPP, of Lowell, reported that their meter bills had been largely increased during the winter, and in some cases the figures were five-fold greater than before. He asked the opinion of those present as to the advisability of making abatements in such cases; but the sentiment of all seemed to be adverse to such a course.

Other remarks were made by Supts. STACY, of Marlboro; COCHRANE, of Nahant; THOMAS, of Lowell; Registrar GLOVER, of Newton; Supt. LOCKWOOD, of Yonkers, N. Y., and others.

Provincial Land Surveyors of Ontario—The 3rd annual meeting will be held in Shaftesbury Hall, Toronto, Feb. 28, 29, March 1. Business will be transacted, reports of committees received and questions discussed. There will be an exhibition of instruments for taking linear measurements, and also of office instruments and appliances. The annual dinner will be at the Walker House, Feb. 29. The following papers will be read: "Determination of the Meridian," CHAS. CARPMAEL, Toronto; "Boundary Commissioners," G. B ABBEY; "Local Improvements," W. M. DAVIS; "Highway Bridges," A. W. CAMPBELL; "Notes on Hydraulics," Prof. GALBRAITH; "Drainage," "Practical Surveying," ALEX. NIVEN. WILLIS CHIPMAN, of Brockville, Ont., is Secretary.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 86).

Streator, Ill.—The works were commenced May 12, 1886, and completed Jan. 10, 1887; they were tested on that date with satisfactory results, 5 streams were thrown simultaneously through 50 ft. of hose to a height of 100 ft., and one stream through 100 ft. of hose to a height of 155 ft., by measurement. The works were designed and built by Goodhue & Birnie, of Springfield, Mass.; the contractors were Bronson & Foster, 52 Broad street, New York City. There are 2 Gaskill pumping engines, with a daily capacity of 1,500,000 galls. each. The stand-pipe is 125 ft. high and 20 ft. diameter. The franchise is for 30 years; the price per hydrant is $45 per annum, or $35 above 112. The franchise is owned by the Streator Aqueduct Co.; President, L. M. BRONSON; Secretary, T. M. BIRNIE; Superintendent, F. D. FERGUSON. The present population is estimated at 14,984.

Phenix, R. I.—The works were designed by H. B. BARTON, of Centreville, R. I., who was also Constructing Engineer. The pipe was supplied by the Warren Foundry & Machine Co., Phillipsburg, N. J., and A. H. McNeal, Burlington, N. J.; the specials by A. H. McNeal and the Fuller Iron Works; the valves and hydrants by R. D. Wood & Co., Philadelphia, and the Ludlow Valve Mfg. Co., Troy, N. Y. The trenching, pipe laying and reservoir work was done by Leach & Baldwin, Philadelphia. The franchise is for 5 years, and the price per hydrant is $30 per annum. The franchise is owned by the Pawtucket Valley Water Co.; President, WM. R. GREENE; Secretary, V. A. BAILEY. The population is estimated at 2,000.

Garden City, Kan.—The works were commenced April 25, 1887, and accepted Sept. 15, 1887. They were designed by J. W. NIER, of Kansas City, Mo., and the Constructing Engineer was J. S. HUMPHREY, of Garden City, Kan. The contractors for trenching, pipe laying and stand-pipe, were E. E. Palmer & Son, of Kansas City, Mo.; for masonry, foundations and buildings, Stevens & Thompson, of Garden City; for pumping machinery, Volker & Felthousen Manufacturing Co., of Buffalo, N. Y.; for pipe, specials, valves and hydrants, South St. Louis Iron Foundry (sub contract for E. E. Palmer & Son). The price paid for trenching and pipe laying was 10 cts. per ft. The stand-pipe is 130 ft. high and 10 ft. diameter. The works are owned and controlled by the city. W. E. TRULL is Superintendent. The present population is estimated at 5,000. There are 1558 ft. of 10-in. cast-iron pipe, 5,028 ft. of 8-in., 4,527 ft. of 6-in. and 4,982 ft. of 4-in., total 16,095 ft.; also 40 hydrants, 10 of which are double nozzle. The pumping plant consists of 2 compound, duplex engines with a daily capacity of 500,000 galls. each, and 200 H.P. boilers. The pump house is of brick 50×30 ft. The water is drawn from a well 17½ ft. diameter and 19 ft. deep; depth of water, 12 ft. The works give good satisfaction. The total cost of the works, including $2,000 for fire apparatus, and engineering expenses, was $42,000.

TO BE CONTINUED.

CONSTRUCTION NEWS.

Water.

Water-Works.—*Maine.*—Eastport. The town has voted to accept a proposition made by the National Water-Works syndicate; the town to pay $4,000 per annum for 60 hydrants. Work is to be commenced at once and completed by 1889.——Farmington. Another effort is being made to secure a water supply, and a contract with the Farmington Water Co. is to be prepared for consideration.——Old Orchard. The water-works have been satisfactorily tested, and the committee will recommend their acceptance.

Massachusetts.—Peabody. A petition for power to improve the water supply is before the Legislature.——Brookfield. A preliminary test of the water-works was made recently.——Athol. There is a proposition for the town to take water from Phillipston pond for fire and domestic use. The Athol Water Co. opposes the scheme.

New York.—Brooklyn. Mr. ADAMS, the new Commissioner of City Works, is endeavoring to induce the Aldermen to take the much needed, but long delayed, action on the new water supply.——Buffalo. The Water Committee has recommended to the Council an appropriation of $400,000 for the improvements mentioned last week.

New Jersey.—Jersey City. A Boston firm has made a proposition to furnish a daily supply of 75,000,000 galls. of water by gravity at lower rates than any yet proposed. Arrangements will be made probably with the North Jersey Water Co., a local company.

Pennsylvania.—Allegheny. The Water Committee has submitted three plans for obtaining a purer supply of water from Nine-Mile island. The first is to pump the water into a steel delivery main at such pressure as to distribute it in the highest parts of the city; estimated cost, $1,500,000. The second is for less powerful engines to pump the water to the present water-works engines; estimated cost, $1,261,408. The third is similar to the first, with the addition of reservoirs and filters; estimated cost, $2,581,936.

Ohio.—Marion. Work has been stopped for 4 months by financial troubles but will be resumed as soon as the weather permits.——Mechanicsburg. The water-works question is being agitated and will be considered at the spring election. There is now no adequate protection from fire, but such protection is much needed.—— Cleveland. It is proposed to sell the West Side reservoir and to apply the proceeds to the new tunnel fund.——Washington C. H. The vote on water-works resulted as follows: for, 977; against, 66; majority in favor, 911. The proposition made by John P. Martin, of Xenia, O., was accepted; work will be commenced in about a month and completed in August. There will be pumping machinery with a daily capacity of 3,000,000 galls., 14 miles of pipe, and 125 hydrants. The city will pay $5,000 per annum for 20 years.

Maryland.—Melvale. The Consumers Water & Illuminating Co., of Baltimore county, GEO. B. MORTON, Chief Engineer, has awarded contracts for the construction of plant at Melvale, to supply Towson town, Govanstown, Mt. Washington, Woodberry, Hampden, Mt. Vernon and the vicinity. There will be a reservoir of 3,000,000 galls. capacity, stand-pipe 55 ft. high, or 122 ft. high above the mains. Gas works will also be erected.—— Baltimore. During January, 5,957 ft. of mains were laid.——Ellicott City. The Catonsville Water Co. will extend its system to supply this place.——Elkton. Water-works are proposed, and a committee has been appointed to report on the necessary proceedings. The report will be made Feb. 21. JOHN S. WIET is Chairman.

Virginia.—Chatham. An offer to build the new water-works has been made by Mr. MCWANE, superintendent of the Glamorgan Iron & Pipe Works, of Lynchburg. Capt. Pigg is preparing plans and specifications for the Council.——Petersburg. The West End Water Co. has been chartered.

Kentucky.—Paris. Plans and estimates for the new water-works are being prepared by Mr. Cosby, of Council Grove, Kan.

North Carolina.—Fayetteville. The contract for water works has not yet been awarded, and proposals may be addressed to F. R. ROSE, chairman of the water-works committee.

Georgia.—Americus. The water-works bonds for $30,000 have been sold to John Hambleton & Co., of Baltimore, for $29,500. Work will be commenced at once.——Atlanta. The city will extend the pipe system.——Rome. The new pump has been put in.

Alabama.—Montgomery. The Capital City Water Co. will extend its mains to the Highland Park property.

Michigan.—Red Jacket. It is proposed to obtain a water supply from Lake Superior. A committee, headed by JOSEPH HERMAN, has been appointed.——Lapeer. The test well for the water-works has struck water at 160 ft.; 3 more wells will be put down.——Marine City. Bonds for $8,000 will be issued to extend the mains.——St. Ignace. Water-works are proposed.

Illinois.—Chicago. The pumping plant at the North Side station is to be rearranged. The crib is to be protected by a breakwater which will be built in the spring; Fitz Simons & Connell have the contract, at $116,500.——Belleville. The City Water Co. has purchased 30 acres of land near the reservoir and will construct a new reservoir 20 ft. deep, with 5 times the capacity of the present one.

Minnesota.—Winona. Arrangements have been made for improving the water-works, but the Mayor refuses to approve the contracts on the ground that the Council has no right to expend over $10,000 for any one purpose, without submitting the matter to public vote.

Iowa.—Vinton. A proposition has been made for water-works. H. T. LAUDERBAUGH is a member of a committee appointed to consider the matter.——Council Bluffs. The Council Bluffs City Water-Works Co. has increased its capital stock from $750,000 to $1,000,000 and will make many improvements in its system.

Wisconsin.—Madison. The Water Commissioners have published a letter drawing attention to the wasteful abuse of the water supply. They recommend a connection with the lake for fire purposes.——Portage,

The works are owned by a company, which receives $40 per hydrant per annum. The population is about 5,500.

Missouri.—St. Louis. An ordinance has been prepared for an appropriation of $62,500 for extending the water system.—Carthage. The water company will extend its mains in the spring.—Washington. A special election on the water-works has been petitioned for, and arrangements are being made.—Nevada. The water-works owned by Col. Perkins, of Springfield, have been sold to the Philadelphia syndicate which recently purchased the Carthage works.

Kansas.—Council Grove. The water-works were opened Feb. 16. There are 4 miles of mains, and a stand-pipe and engine. An electric light plant has also been put in. [We have to acknowledge with thanks the receipt of an invitation to the opening ceremonies. ED.] —Hiawatha. The water supply is drawn from 13 wells and pumped to a stand-pipe.

Colorado.—Sterling. Water-works will be built this spring, at a cost of $40,000. The water will be supplied by gravity from springs 6 miles distant.

Utah.—Ogden. The City Council will make many important changes in the water-works system to increase the supply.

Texas.—Texarkana. The Texarkana Water-Works Co. has been incorporated by W. BEHAN, W. L. WHITAKER and R. D. HANELL. Capital stock, $30,000.

Nebraska.—Charles Schroeder, of Columbus, Neb., reports work well under way on the water-works for Loup City and St. Paul, Neb. He is making additions to the works at Columbus, Neb., and will construct this spring works for David City, Stromsburg, and Pawnee City.

Vermont.—W. H. Lang, Goodhue & Co., of Burlington, Vt., put in, during the last year, water-works at Swanton, Vt., Lebanon, N. H., and Saranac, N. Y.

Iowa.—S. K. Filton, of Omaha, Neb., has recently completed water-works at Neola, Ia., and Ord, Neb.

Garden City, Kan.—The sewerage system was designed by J. S. HUMPHREY, and the main sewer was constructed under his supervision. The main sewer is 7,000 ft. long and 12 ins. diameter. There are 17 catch basins and 18 manholes, the castings for which were furnished by H. A. Keefer, of Kansas City, Mo. The sewer pipe was furnished by C. A. Brocket, of Kansas City. There are Y branch connections laid for every lot or abutting property. The Arkansas river is the outlet of the sewer. The grade is 15 ins. per 100 ft; the bottom of the sewer pipe is about 4 ins. below ground water line, and the pipe is laid on pine plank for nearly a mile. The tested velocity of the current, sewer half full, is 2.1 ft. per second; the calculated velocity was 2 ft. per second. The cost of the improvement was $6,500.

Lake, Ill.—On Jan. 31, the Board of Trustees adopted the plans and specifications submitted by Mr. HORN, the Town Engineer, for a sewage pumping station on the Shone hydro-pneumatic system. The pneumatic ejectors will be placed underneath the surface of the street at the intersection of 69th and Halsted streets and will be capable of lifting 1,200 galls. of sewage per minute against a head of 30 ft. The air compressors will be placed about 700 ft. from the ejectors. By adopting this system the nuisance of a sewage pump well in a residence district is avoided. The work will be done by the Shone Hydro-Pneumatic Sewerage & Water Supply Co., of Chicago; URBAN H. BROUGHTON, A. M. I. C. E., Engineer and Manager.

The Tremont Meter in Boston.—According to a late editorial in the Boston *Daily Advertiser*, the Tremont water meter scandal is assuming a still more variegated form, if such a thing is possible. After selling 4,000 worthless and now rejected meters to the city at a high price, the company, through its assignees, has brought in a claim of about $9,000 for repairs mainly to its own meters. The peculiar thing about this affair is that the law officer of the city, while holding that the company's bond for faithful fulfillment of contract is worthless to the city, says the city must pay the claim for "repairs," etc., and accordingly $6,600 has been so paid. The company also still maintains a claim against the city for a violation of contract on its part. As the *Advertiser* says, the whole thing is shameful and the more the matter is stirred up the dirtier the mess seems to become. In this connection it might be asked what has become of the "general and public" test of water meters, which was ended in Boston last October and upon which no report has appeared, so far as this journal has been able to discover.

Spokane, Wash. Ter.—Report on Water-Works, Sewerage and Drainage, and Street Grades.—Maj. ALFRED F. STEARS, C. E., made a report to the City Council, last Fall, on the above proposed works: *Water-Works.* It is proposed to sink a well through the gravel into the bed of the river at such distance above the city as to insure safety from sewage pollution, and to put in Holly engines for the direct pumping system. The well would be about 20 ft. diameter and 20 ft. deep. The cost of the works is estimated at $18,000, the operating expenses at $3,200 per annum and the first year income at $5,960; net income for first year, $2,760. The operating expenses might be reduced by building a wooden tank, and pumping into it during the day a supply sufficient for the night; under this plan, however, a steam fire-engine would be needed. —*Drainage.* The city is so situated that storm water is easily carried on the surface without resorting to the expense of underground pipes, using the ditch traversing the town, which can be made efficient by a few alterations and improvements.—*Sewerage.* Attention is called to the fact that the present wells and cess-pools are rarely 30 ft. apart, the wells are 20 to 30 ft. deep and the cess-pools 6 to 8 ft. deep, the arrangement being such as to drain the sewage into the wells. Three methods of disposal are mentioned: one is to pipe the sewage to the lake (a fall of 35 ft. in less than 2 miles), the alkaline water of which, while rendering it unfit for use, will tend to render the sewage innocuous; the second plan is to pipe the sewage from the city and use it for irrigation; either of these plans would cost about $17,000, or $1.10 per lin. ft. in Sprague. The third plan and the one recommended, is to discharge the sewage into the river, which is a mountain torrent having a fall of about 20 ft. per mile from above the city to the lake.—*Grades.* There would be about 9,000 cu. yds. of bank for establishing proper grades for the streets. On 80 ft. streets the middle to be 18 ins. higher than the bottom of the gutters, and on 60 ft. streets to be 14 ins. higher. Gutters to be of wood.

Cheyenne, Wyo., Water-Works.—The first water system was constructed in 1880 by the Union Pacific Ry. Co., water being pumped from Crow creek to a tank and distributed by 3,000 ft. of mains in the business part of the city and to the railroad shops. The people depended almost entirely on a supply derived from wells. In 1882, the city council under plans prepared by WILLIAM G. PROVINES, City Engineer, commenced the construction of the present system by drawing the supply of water by gravity from a natural basin, known as basin No. 4 or Lake Mahpealutah, 1½ miles from the business center of the city. The 4 large basins designated by the city engineer as numbers 1, 2, 3 and 4, in which water is stored, have a capacity of 214,000,000 galls. at an average height of 85 to 100 ft. above the city. The water is taken from Crow creek at a dam 6 miles above the city, and is carried in vitrified stoneware pipes, 15 and 20 ins. diameter, to basin No. 1, and similar pipes 3 miles in length, connect the four basins. The maximum capacity of this pipe is 2,500,000 galls. per day but is rarely run more than ½ full. The supply at that point, except in extreme drouths of short duration, is 5,000,000 to 10,000,000 galls. From the lowest of the basins, No. 4, (Lake Mahpealutah) a 12-in. cast-iron pipe conveys to the city 2,514,000 galls. of water per day. There are in the city 11¼ miles of service pipes, 74 double nozzle hydrants, and 71 gate valves. The total cost of the water system has been about $200,000. The expense of the system last year did not exceed $5,000, while the revenue derived during that period was over $13,000. Water is used freely, for irrigation and other purposes. The Union Pacific Railroad is daily furnished 200,000 galls., nearly one-quarter of the entire amount of water consumed in the city, at $1,640 per annum. An 80 H. P. Knowles pump is kept in readiness at all times to put on extra pressure in case of fires, and is connected with the city alarm system. The gravity pressure in the business center of the town is 18 to 20 lbs. and is sufficient for all ordinary purposes.

City Engineer DONNELL MILLER states that it will soon be necessary for the city to lay an additional pipe line, and that in his opinion the city could construct 3 reservoirs of requisite depth in the south end of basin No. 1, which would hold 3,000,000 galls. each, and furnish an abundant supply of clear water at all times, and would not cover more than one acre in area.

The cost of this improvement, together with 1¼ miles of 12-in. pipe to intersect the main pipe line south of basin No. 1, would not exceed $15,000 or $20,000. The reservoir would be 30 ft. higher than the present source of supply, thereby increasing the pressure in the pipes, and enabling the capitol and high buildings to have water on the top floors without pumping. It would also furnish a separate reservoir from which to derive a supply of water during such time as the other basins are being cleaned, and especially if the capacity of basin No. 4 (or Mahpealutah) is increased by deepening and raising the banks. This lake, the largest of the chain, covering 38 acres, can be increased three or four fold, as its banks can be raised 18 or 20 ft. at small expense. The other lakes can also be deepened to prevent vegetable growth. Another important improvement could be made at the dam by extending the present pipe 500 or 600 ft. up the creek, resting on bed-rock, so that the water could be taken as low as possible below the surface by a system of natural filtration, through a number of perforated pipes with wire screens similar to those used in a drive well. It is well known that there is always flowing a supply of clear water on the bed rock of Crow creek. The average daily consumption is about 500,000 galls.

Water Contracts—An Assembly Bill (No. 252) has been introduced into the New Jersey State Legislature by Mr. BROWN, making it unlawful for the authorities or any department of any city of the State now or hereafter owning or controlling its water-works, to enter into a contract for the supply of water, with any person or persons or private corporation for the water supply of said city. All such contracts to be illegal, and any money paid under such contracts by the city authorities shall be a misdemeanor, and punishable by fine or imprisonment or both. In case of accident or emergency, a temporary agreement for water may be made. The bill is offered by the Committee on Jersey City Water Supply, and has been referred to the Committee on Municipal Corporations.

Proposals Open.

Canal Basin.—Proposals for the basin at Perth, Ont., in connection with the Tay canal improvements will be advertised for shortly. There will be masonry and dredging. Estimated cost, $80,000.

Water-Works.—O. SACKETT, Town Clerk, Avon, N. Y.

Water-Works.—F. R. ROSE, Chairman, Water-Works Committee, Fayetteville, N. C.

Inclined Plane.—To Price Hill. JOHN KILGOUR, 5th and Walnut streets, Cincinnati, O. Feb. 20.

Drains.—Sewer pipe, 18 and 12 ins.; brick manholes, cast-iron receiving basins. THOS. J. LANAHAN, Clerk, Board of Contract and Apportionment, Albany, N. Y. Feb. 20.

Street Work.—Grading, curbing and paving with oblong dimension granite blocks. THOS. J. LANAHAN (as above). Feb. 20.

Stone Arch Bridge.—At Danielsonville, Conn. Span 44 ft., length 32 ft. C. E. CHANDLER, Norwich, Conn., is engineer. The SELECTMEN of KILLINGLY, Norwich, Conn. Feb. 23.

Sewers.—Pipe sewers, 12 and 15-in. HENRY FLAD, President, Board of Public Improvements. St. Louis, Mo. Feb. 23.

Granite Paving.—HENRY FLAD, (as above). Feb. 24.

Brick Building.—For the Fire Department. HENRY FLAD, (as above). Feb. 25.

Water Supply.—Pure supply, to be delivered into reservoirs 2 and 3, on Bergen Hill, Jersey City, and into the high service distribution pipes, at an effective head of 100 ft. above high water level in the reservoirs. Proposers to own or control a supply of not less than 30,000,000 galls. per day. Plans and specifications prepared by the Chief Engineer of the Board of Public Works. WM. F. KERN, Esq., President, Board of Public Works, Jersey City, N. J. Feb. 27.

City Hall.—At Garrettsville, O. Architect, SAMUEL W. LANE, Cleveland, O. E. L. DAVIS, Village Clerk, office of R. S. Webb, Garrettsville, O. Feb. 27.

Water Bonds.—For $24,000. W. E. DORRINGTON, Mayor, Falls City, Neb. Feb. 27.

Town Hall.—Mason and carpenter work. Architect, EDGAR B. PECK, 5 Custom House street, Providence. WM. GREGORY, Chairman of Building Committee, Wickford, R. I. Feb. 27.

Cut Stone and Laying Water Mains.—The Commissioner of Public Works, 31 Chambers street, New York City. Feb. 28.

Flagging Sidewalk—JOHN P. ADAMS, Commissioner of City Works, Brooklyn, N. Y. Feb. 28.

Retaining Wall.—On the river front of the capitol grounds at Jefferson City, Mo.; 55,000 to 60,000 cu. ft. of masonry, range work and cut stone work. J. B. LEGG, Architect, Governor's Office, Jefferson City, Mo. Feb. 29.

Dredging.—In Mott Haven canal: 15,443 cu. yds. of mud and deposit. Price per cu. yd. or lump sum. JAMES C. BAYLES, President, Health Department, 301 Mott street, New York City, March 1.

Dredging.—In Cuyahoga river. WALTER V. RICE, City Engineer, Cleveland, O. March 1.

Water-Works.—Stand-pipe system, or direct pressure system. Engineer, W. KIERSTED, Kansas City, Mo. WM. E. DORRINGTON, Mayor, Falls City, Neb. March 1.

Paving and Curbing.—Granite paving block, 95,000, 8 to 12 ins. x 3½ to 4½ ins. x 7 to 8½ ins.; also 650 ft. of granite curbing. HENRY WINKLER, Chairman, Committee on Highways, Holyoke, Mass. March 2.

Dredging.—In docks on the Delaware and Schuylkill rivers. GEO. A. COTTON, President, Board of Wardens, Philadelphia, Pa. March 7.

Contracting.

Stand-Pipe.—The following were the proposals received for a stand-pipe 103 ft. high and 20 ft. diameter for the water works at Mansfield, Mass.: E. Hodge & Co., East Boston, $5,820; Robinson Boiler Works, East Boston, $5,850; Cunningham Iron Works, Boston, $6,400; Worcester Steam Boiler Works, Worcester, Mass. $6,990; Whittier Machine Co., Boston, $7,766; E. Kendall & Sons Cambridge, Mass., $9,000 The contract was awarded to E. Hodge & Co.

Repairing Steamer.—The following proposals for repairs to the U.S. Steamer "Tourist" were opened Feb. 11 by Lt. Col. GILLESPIE, U. S. Engineer office, Boston, Mass.: E. Hodge & Co. East Boston, $3,175; Sylvester Smith, $3,475; Foster, $4,175; Atlantic Works, East Boston, $4,230. All the bids were rejected, the amounts being in excess of the appropriation.

Boilers.—The following proposals have been received for 6 steel boilers, 66 ins. diameter and 18 ft. long, for the water-works at Nashville, Tenn.: Union Iron Works, Chattanooga, $8,900; Erie City Iron Works, Erie, Pa., $10,267; B. G. Wood, Nashville, $10,355; Wm. Culbut, Nashville, $11,936. The contract was awarded to the Union Iron Works. GEO. REYER, Superintendent of Water-Works; F. E. KUHN, Secretary of Board of Public Works and Affairs.

Sewer Outlet.—The Board of Public Works, Milwaukee, Wis., has awarded the contract for docking the outlet of the flushing tunnel to W. T. Casgrain & Co., of Milwaukee.

Gas Pipe.—The following proposals for 4,000 ft. of 1½ in. gas pipe for the Park fence, have been received by JAMES BROWN, Comptroller, Allegheny, Pa.: Kelly, Jones & Co., Pittsburg, 7¾ cts. per ft.; Union Foundry & Machine Co., Allegheny, 7⅞ cts.; James Hay, Allegheny, 8 cts.; Oil Well Supply Co, Pittsburg, 8¼ cts.; H. T. Oinhausen, Pittsburg, 10 cts. The contract was awarded to Kelly, Jones & Co.

Plumbing Supplies.—The following proposals have been received by B. P. MORTON, Superintendent of Water-Works, Newport, Ky.: Stop-cock boxes: Bingham & Taylor, 93 cts. each; Globe Foundry, $2; contract not awarded.——Stop and service cocks, ¾-in.: R. Hesterling & Co., $1 per pair, 1 of each; Geo. Fewlass, $1.04; Alex. Rigler, $1.10; Bourbon Copper & Brass Works, $1.20; Troy Globe Valve Co., $1.20; the contract was awarded to Geo. Fewlass.——Lead pipe and solder: the contract was awarded to Jas. McDonald & Sons at 5¾ cts. for lead pipe and 21 cts. per lb. for solder.——Plumbing and excavation: Wm. White, $2.20 for each branch, $3 per day for plumber and helper on repairs; Geo. J. White, $2.75 for each branch, $4.50 per day for plumber and helper on repairs; the contract was awarded to Wm. White.

Granite Roads.—G. F. Smith & Co., of Jonesville, Mich., have issued a pamphlet descriptive of the "granite roads," of the construction of which they make a specialty in the west. Granite roads (improved Telford) of quarry refuse, have been made in eastern States for several years, but only within the last 4 years have attempts been made by western cities to utilize the granite boulders of Michigan. The system is in use at Jackson, Mich., and Fort Wayne, Ind. The pamphlet contains a description of the construction of the road and testimonials from the cities above mentioned.

Water-Pipe.—The following proposals for 4, 6, 8 and 12-in. cast iron pipe were received Feb. 7 by H. C. COTTER, Supt. of Water-Works, Toledo, O.: Ohio Pipe Co., Columbus, O., $25.83 per ton; Lake Shore Foundry Co., Cleveland, O., $27.10; Addyston Pipe & Steel Co., Cincinnati, O., $27.34; New Philadelphia Pipe Works, New Philadelphia, O., $27.50; Detroit Pipe & Foundry Co., Detroit, Mich., $29; Shickle, Harrison & Howard Iron Co., St. Louis, Mo., $33. For immediate delivery there were but two changes from the above: New Philadelphia Pipe Works, $26.60; Detroit Pipe & Foundry Co., $28.90. The contract was awarded to the Ohio Pipe Co.

Sewer Pipe.—The following proposals have been received by W. E. CUTSHAW, City Engineer, Richmond, Va.: West & Branch, Richmond: Akron pipe, 6 in., 30 cts.; 8-in., 45 cts.; 10-in., 65 cts.; 12 in., 85 cts.; discount off, branches, etc., included, 60 per cent.; A. & G. Bargamin, Richmond, West Virginia pipe, same prices and discount; John Bowers, Richmond, West Virginia pipe; same prices and discount; Warner Moore, Richmond, West Virginia pipe, same prices, discount 50%; Blackmer & Post, St. Louis, Mo., 30, 40, 60 and 75 cts., discount 60% for 3 to 8-in., and 50% for 9 to 12-in.

Pumps.—Bids for pumps for the water-works at Henderson, Ky., were opened Feb. 1, by the Water-Works Committee, and on Feb. 2 the commissioners recommended the Gordon & Maxwell pumps to the City Council. All the bids were rejected, and a committee was appointed, with P. SASSEEN, Mayor, as Chairman, to readvertise for bids. FRED. KLEIDERER, Secretary and Treasurer, Henderson water-works.

Sewers for Fort Smith, Ark.—The following were the proposals received by the Board of Sewer Commissioners for sewers in District No. 1: John J. Everson, Akron, O., $144,528; Everson and Liddle, Lockport, N. Y., $161,406; W. A. Doyle, Kalamazoo, Mich., $161,670; Geo. S. Miller, Council Bluffs, Ia., $176,795; J. P. Hughes, Fort Worth, Tex., $191,400; Fruin Bambrick Construction Co., St. Louis, Mo., $207,015.30; S. J. Ronan & L. W. Hoag, Fort Smith, $214,400; M. & J. Hayes, Springfield, Mo., $260,405; Bailey & Kountz, Cleveland, O.; J. J. Peter & M. Steel, Cincinnati, O.; T. C. Brooks & Co., Jackson, Mich.; Thos. Jones, Leavenworth, Kan.; J. M. Reardon & Co., Lake View, Ill. The engineer is J. P. BATES.

The following were the prices of J. J. Everson's bid, which was the lowest: brick sewer, 45 ins. internal diameter, $5.25 per lin. ft.; 28 ins., $2.70; 24 ins., $2.20; 8-in. pipe, including Y's, branches and joints, 20 cts. per ft.; 10-in., 28 cts.; 12-in., 34 cts.; 15-in., 45 cts.; 18 in., 67 cts.; 21-in., $1.10; 24-in., $1.64; lampholes, $5 each; flush tanks, $60 each; manholes $35 to $38 each for brick and pipe sewers; excavation and back filling, 6 to 24 ft., 19 cts. to $2.60 per lin. ft.; rubble masonry, $6.50 per cu. yd.; concrete masonry, $5 per cu. yd.; timber in foundations, $28 per 1,000 ft. B. M.; water supply pipe, laid, 30 cts. per lin. ft.; receiving basins, $60 each; rock trench per foot in depth, 30 cts. per lin. ft.; embankment, 40 cts. per cu. yd.; iron pipe, with lead joints complete, $45 per ton; 6-in tile drain, 20 cts. per lin. ft. Total, $144,528.

Sewers.—*Allegheny, Pa.*—Contracts have been awarded to the following bidders by JAMES BROWN, Comptroller: E. J. McIlwain, H. Lafferty and L. Sloan.

Lincoln, Neb.—The following proposals have been received for the extension of the N street sewer: Carr & Waters, $10.05 per lin. ft.; H. Murphy, $11.90; W. F. Woods, $16.50; Eugene Woerner, $15.90. The contract was awarded to Carr & Waters. The work will cost about $3,500.

Brooklyn, N. Y.—The City Works Department will build a new sewer in the 17th Ward at a cost of about $70,000. The size will range from 48 to 60 ins.

Atlanta, Ga.—The city council has appropriated $55,000 for sewers.

Jersey City, N. J.—The following proposals have been received by the Board of Public Works: Halladay street sewer; E. W. Keeney, 24-in. brick sewer, $3.90 per lin. ft.; rock excavation, $3 per cu. yd.; receiving basins, $85 each; concrete, $2 per cu. yd.; M. B. Allen, $2.64, $1, $85, 50 cts.; Michael Mullery, $2.73, $3, $70, 1 ct.; Hy. H. Holmes, $2.74, $1.75, $75, $1; P. W. Connelly & M. Murray, $3.40, $2, $110, $1; P. J. Condon, $2.65, 1 ct., $85, 1 ct; Chas. O'Neill, $3.25, $1.75, $80, $1.——Webster avenue sewer: Thomas Cavanagh, 24-in. brick sewer, $4.85 per lin. ft.; rock excavation, $4.75 per cu. yd.; concrete, $2 per cu. yd.; Dennis Byrnes, $2.88, $2.95, $1; C. O'Neill, $3, $1.75, $1; Thomas Cogan, $3.50, $3, $1; M. B. Allen, $2.50, $1, 50 cts.——Reconstructing sewer in Halladay street; P. W. Connelly & M. Murray; piles, 25 cts. per lin. ft.; hemlock, 2 cts. per ft; wrought iron bolts, 7 cts. per lb; 24-in. brick oval sewer on piles, $3.50 per lin. ft.; masonry, $4 per cu. yd.; M. Mullery, 23 cts., 3 and 2½ cts., 55 cts., $2.65, $3.50; Thomas Cogan, 20 cts., 2⅞ cts., 4 cts., $2.90, $3.

Bridge.—At Atlanta, Ga., the contract for the iron work for the Nelson street bridge has been awarded to the Atlanta Bridge & Axle Works, and the masonry to Wm. McConnel.

Railroad Contracts.—*Pittsburg, Cincinnati & St. Louis Ry.*—The contracts for grading and masonry on the McDonald's & Bridgeville branch of the Chartiers Ry. have been awarded as follows by M. J. BECKER, Chief Engineer: Section No. 19, to Van Dyke & Wilson, Derry Station, Pa.; Nos. 20 and 22, to Miller & McCann, Steubenville, O.; No. 21, to J. R. De Witt, Jr., Washington, Pa.; Nos. 23 and 24, to Timothy Scanlon, Pittsburg, Pa.

McKeesport & Bellevernon Ry.—The contract has been awarded to Drake & Stratton, Pittsburg, Pa.

Allegheny & Kinzua Ry.—The contract for this line from Bradford, Pa., on the N. Y., L. E. & W. Ry., to Cattaraugus county, N. Y., 22 miles, has been awarded to J. W. Watson and D. Shine, Olean, N. Y.

Carolina, Knoxville & Western Ry.—The following were the bidders for work on the Tennessee and North Carolina divisions: J. M. Brooks & Co.; S. A. Walker & Co.; Kneis, Johnson & Co.; J. B. Upton & Co.; Joseph Reed; McCabe, Condon & Co.; McDonald, Campbell & Co.; McDonald, Shea, Dunavant & Co.; Chandler & Shea; H. Y. Griffith & Co.; all of Knoxville, Tenn.; F. B. Redmond, S. S. Eaton; R. T. Martin; S. S. Eaton & Co., all of Chattanooga, Tenn.; Fortune & Brown, Asheville, N. C.; D. L. Boyd, Newport, Tenn.; Wm. Neighbert, Sons & Co., Oliver, Tenn.; John Hasson, Rogersville, Tenn.; C. D. Smith & Co., Birmingham, Ala.; Corpenning, Smith & Armstrong, Birmingham, Ala.; W. G. Corpenning & Co., Birmingham, Ala.; Tanner & Robinson, Cowpens, S. C.; T. F. Mitchell & Co., Covington, Ky.; Keen Bros. Construction Co., St. Louis, Mo.; R. Ryan & Co., Greenville, O.; Patrick Kelley, Crawfish Springs, Ga.; Arnold & King, Fort Smith, Ark.; J. H. Burckhalter, Augusta, Ga. The South Carolina division was not let. The Tennessee division was let to Fortune & Brown, of Asheville, N. C., and the North Carolina division to D. L. Boyd, of Newport, Tenn. J. W. FLETCHER, Knoxville, Tenn., is Secretary. GORDON GARDNER is Chief Engineer.

Blackville, Newberry & Alston Ry.—The contract for grading was awarded to J. L. Irving. Locomotives have been purchased from the Rogers Locomotive Works. GEO. A. WAGENER, Charleston, S. C., is President.

Nashville & Knoxville Ry.—Contracts have been awarded to Davis & Canty, of Nashville, Tenn., and Shaffer, Coffey & Co., of St. Louis, Mo.

Southern & Western Air Line Ry.—The contract for 55 miles between Shelby and Cranberry, S. C., has been awarded to S. D. Dunavant, of Knoxville, Tenn. The road connects with the Carolina Central Ry. at Shelby.

Kansas City & Sabine Pass Ry.—The contracts for the complete construction of the line between Kansas City and Pierce City has been awarded to the Kansas City & Sabine Pass Construction Co., the officers of which are officers of the railway company. This part of the line, 117 miles, is to be built this year, and the 547 miles from Pierce City to Sabine Pass, next year.

RAILROADS

East of Chicago.

Existing Roads

New York, Lake Erie & Western.—Engineers are locating a new line between Ridgewood, N. J., and Suffern, to avoid the heavy grades by the old route. A third track is to be laid from Suffern to Middletown, and a new line will soon be run from Middletown to Port Jervis.

Pennsylvania.—The Bridgeville & McDonald branch of the Chartiers railway is to be built this season. Contracts have been let for 6 miles, and the other half of the line will probably be let at an early date.

Cumberland Ry. & Coal Co.—This company is now grading a branch 14 miles in length, from Spring Hill mines, Nova Scotia, to the village of Oxford, to connect with the Oxford & New Glasgow Ry. (under construction by the Dominion Government.) The work will be finished during the coming summer. R. W. LEONARD is Chief Engineer and J. W. CHANDLER, contractor.

Lehigh Valley.—A new item of interest in connection with the line which this company has surveyed from Geneva to Buffalo, N. Y., is that the company has made traffic agreements with the managers of the new Soo route, and will build two or more large steel propellors for carrying grain between Gladstone, Mich., and Buffalo.

Schuylkill & Lehigh Valley.—The Philadelphia *Enquirer* says that this road, which has been in process of construction for 25 years, is to be pushed to completion. The line will extend from Bowman's Station on the Lehigh Valley Railroad to Tremont, Schuylkill county, and will give access to a coal mining region.

New York, Pennsylvania & Ohio.—The annual report describes the heavy traffic on the division between Youngstown and Cleveland, and states that it is deemed necessary in order to prevent traffic from being diverted to other lines to double track this line, 67 miles in length, and build modern steam elevators at the ore docks at Cleveland. The total cost of these improvements will be $1,560,000.

Canadian Pacific.—The total track laying on the system during 1887 was 255 miles. At a recent meeting the directors voted to build a line from Sudbury Junction to Claremont, Ont. A preliminary survey was made a year ago, and the permanent location will be undertaken at once. This move is made necessary by the recent loss of the Northern and Northwestern systems. The distance is about 100 miles.

Grand Trunk.—Chief Engineer HANNAFORD informs us that about 10 or 12 miles of track have been laid on the extension from Fort Covington to Messina Springs, N. Y., but that the line will not be finished and open for business till early summer. The three mile loop-line from Lachine to Dorval will be completed about the same time. The Portland *Press* makes the following comparison of the Grand Trunk traffic in 1854 and 1887:

Report for 1854.

Number of passengers	117,806
Number of tons freight	116,571
Passenger receipts	$153,520
Mail and express receipts	29,380
Freight receipts	279,200
Total expenses	361,760

Report for 1887.

Number of passengers	5,535,097
Number of tons freight	6,942,194
Passenger receipts	$5,533,556
Mail and express receipts	637,545
Freight receipts	12,216,600
Total expenses	12,568,910

It is generally agreed that the extension to Sault Ste. Marie which has long been rumored, and for which surveys have been made, is now pretty well assured by the recent absorption of the Northern and Northwestern systems.

New Projects and Surveys.

Evansville, Suburban & Newburg.—This is the name of a proposed dummy line, at Evansville, Ind., for which stock subscriptions and right-of-way are being secured.

Youngstown & Buffalo.—This company proposes a line from the mouth of the Niagara river to Lewiston. S. PARK BAKER is Vice-President.

Nashville & Knoxville.—Chief Engineer CHAS. J. ALLISON favors us with data regarding this Tennessee line. The road is to extend from Lebanon to Knoxville, Tenn., a total length, including branches, of between 150 and 200 miles. Grading is now in progress on 80 miles of the line under contractors Shaffer, Coffey & Ware, Jno. Coyne, Davis & Canty and J. C. Rodemer & Co.; and track laying has just begun. Surveys are now in progress on some of the proposed branch lines and further contracts will be let as soon as the work can be made ready. The work is very heavy but good grades have been secured. The line has several bridges and one tunnel. It is expected to open 40 miles for traffic by July 1. A. L. CRAWFORD, of New Castle, Pa., is President.

Carolina, Knoxville & Western.—Grading has commenced on the line of this road near Knoxville, Tenn., and a large force will be put on all along the line from Knoxville to Greenville, S. C. as soon as the weather permits. W. L. MAULDIN, of Greenville, S. C., is President; GORDON GARDNER, of Augusta, is Chief Engineer.

Atlantic & Danville.—Track was laid on this road in 1887 from West Norfolk, Va., to Suffolk, 18 miles. G. O. S. BRUCE, of Suffolk, is Chief Engineer and Superintendent of Construction.

Orlando & Winter Park.—The city of Orlando, Fla., is trying to raise funds to aid the building of this road to Lake Jessup and also a branch line to Oviedo.

Kanawha & Ohio.—The proposed extension of this road up the Kanawha river from Charleston, W. Va., is reported to be again under consideration. The right of way has been secured for a distance of 30 miles.

Augusta, Gibson & Sandersville.—At the annual meeting held in Augusta, Ga., Feb. 8, it was voted to accept the new charter granted by the last legislature, permitting the company to extend its line from Sandersville *via* Hawkinsville and Albany to the Alabama State line and to build boats for Savannah river traffic.

East Alabama.—The company has ordered the location to be made to complete the gap of about 35 miles from Roanoke, the present terminus, to Anniston. The total distance from Opelika to Anniston is about 90 miles. Construction will be ordered as soon as location is finished. BENJ. H. HARDAWAY, Chief Engineer, is now making the locating survey.

East Tennessee, Virginia & Georgia.—Press reports state that a line is to be built from Jesup, Ga., to Jacksonville, Fla., and surveys are in progress.

New Projects and Surveys.

Osceola & Lake Jessup.—This company has been organized by JUDSON KINGSLEY, of Troy, N. Y., ANDREW G. HAINES of New York City, JOHN R. MIZELL of Winter Park, Fla., and others, to build a 13 mile railroad from a point on the Orlando & Winter Park Railroad *via* Oviedo to Lake Jessup.

Birmingham, Mobile & Navy Cove Harbor.—A charter has been filed for an extension of this line to Pensacola, Fla., and the company will ask a grant of right of way and terminal facilities from the city. The incorporators of the company are Gen. JOHN MCNULTA, Receiver of the Wabash; SAMUEL W. ALLERTON, of Chicago; THADDEUS MCNULTA, of Mobile, and others.

Virginia.—Bills are pending in the legislature in reference to the charters of the following railroad companies: Hunters Valley; Surry & Smithfield; West Norfolk & Carolina; Portsmouth & South Mills; New River Plateau; Mineral Springs; Virginia, North Carolina, Tennessee & Western, THOS. BREEN, Knowlton, Pa., President; Bristol & Danville; Jos. R. ANDERSON, Bristol, Tenn., President.

Kentucky.—Bills are pending in the legislature concerning the charters of the following railway companies: Lexington & Madison; Richmond, Irvine & Beattyville; Paducah Belt; Cumberland Valley & Eastern; Powell's Valley.

Virginia.

WARRENTON, Va., Feb. 11.—A meeting of the citizens of Warrenton and Fauquier county was held here yesterday, the object being to organize a movement looking to the building of a trunk line from Washington City by Warrington to Luray Cavern, Harrisburg, Staunton, Charleston, W. Va., and thence to St. Louis. The meeting was addressed by Gen. LAFAYETTE BINGHAM, of Washington City. A committee of five, consisting of Messrs. J. P. JEFFRIES, A. D. PAYNE, T. T. SMITH, GRENVILLE GAINES and H. H. SPINDLE, were appointed to confer with the various towns and counties through which the road will pass, seeking co-operative action with Fauquier in this railroad enterprise.—*Baltimore Sun.*

Etowah Mining & Manufacturing Co.—Bids are asked by this company, at Cartersville, Ga., for building a railroad from its mines to the Western & Atlantic Railroad.

THE NORTHWEST.

Existing Roads.

Great Northwest Central,—

BRANDON, Manitoba, Feb. 3, 1888.

EDITOR ENGINEERING NEWS:

The Great Northwest Central Ry. is projected to run from Brandon *via* Rapid City to Battleford, 450 miles. The location is complete for the first 100 miles. The first 50 miles are under contract, and 26 miles are graded. The section under contract is to be completed by July 1, next. We expect to grade about 100 miles more this year, and will let contracts probably about June 1. The work is medium; maximum grade is 60 ft. per mile. The line will open up a large tract of country for settlement. The company has a land grant of 6,400 acres per mile. Hon. Senator CLEMOW, of Ottawa, is President, and W. A. ALLAN, of Ottawa, is Secretary.

J. H. E. SECRETAN, *Chief Engineer.*

Chicago, Milwaukee & St. Paul.—Much guess work is being expended over the probable destination of the extension which is to be made from Tomahawk Lake in Northern Wisconsin. Surveys have been made from Tomahawk Lake to Manistique, Mich., and lines from that point to Ashland, Union Bay and L'Anse are frequently reported.

New Projects and Surveys.

Chicago, St. Paul, Nebraska & Kansas.—Articles of consolidation have been filed in Kansas and Nebraska of the Chicago, St. Paul & Kansas and the Kansas, Nebraska & Decatur railway companies under the above title. The total length of the proposed lines and branches, which are located with the broad generality and generous extent in which the Kansas incorporator delights, is about 700 miles. The general offices of the company are to be at Salina, Kan.

Quincy Transfer & Belt.—This company has been incorporated in Illinois to build a belt railroad at Quincy. Capital stock, $100,000. Incorporators, F. D. SCHERMERHORN, J. F. DURANT, HENRY ROOT, and J. H. DUKER.

St. Louis & Springfield,—Incorporated in Illinois to build a railroad from Mount Olive to East St. Louis, by L. S. GRAVES, W. O. BROWNING, L. L. CHAPMAN, and others, of Springfield.

THE SOUTHWEST.

Existing Roads.

St. Louis, Arkansas & Texas.—The following little table of data concerning the recent extensions of the "Cotton Belt" system is sent us by Chief Engineer J. F. HINCKLEY and certainly makes a creditable showing for the engineering staff of the road.

Name of extension.	per cent. tangent.	per cent. of curve.	per cent of excess over Air Line.
Sherman,	.8673	.1327	.0832
Arkansas & Sou'rn,	.8814	.1186	.0234
Little Rock & Ea'rn,	.9463	.0537	.0852
Corsicana & Hillsboro,	.8864	.1136	.0478
Fort Worth,	.8614	.1386	.0739

All branches cost less than the approximate estimates.

Kansas City, Independence & Lee's Summit.—Chief Engineer WILLIAM B. KNIGHT writes us that the locating surveys were completed last November from the junction with the Kansas City Belt Ry. to Lee's Summit, a distance of 18 miles. Right of way has been partly secured and negotiations are in progress for putting the line under contract as soon as practicable.

Fort Worth & Rio Grande.—

FORT WORTH, Tex., Feb. 5, 1888.

EDITOR ENGINEERING NEWS:

Track was laid on this road during 1887 from Fort Worth, Tex., to Granbury, 40.2 miles. The line will probably be extended at an early date *via* Stephensville, Comanche, and Dublin to Brownwood, 108 miles.

C. B. COLTON, *General Superintendent.*

Atchison, Topeka & Santa Fé.—For the following list of the contractors who built the 816 miles of extensions of the Santa Fé system in Kansas, Indian Territory and the Texas Panhandle during 1887, we are indebted to the courtesy of LEWIS KINGMAN, Assistant Engineer.

J. H. Hampson, Contractor for Bridging and Grading.
Barney Lantry & Sons, Contractors for Masonry and Grading.
Wm. Garland, Contractor for Grading.
Ward & Courtney, Contractors for Grading.

C. Shenfield,	"	"	"
John Scott & Son,	"	"	"
Covert & Clark,	"	"	"
J. K. Wright,	"	"	"
John R. Price,	"	"	"
Price & McGavock,	"	"	"
A. A. Grant,	"	"	"
L. W. Lewis,	"	"	Masonry.
Alexander & Nelson,	"	"	Grading.
Nelson & Co.,	"	"	"

Marshall, Paris & Northwestern.—

PARIS, Tex., Feb. 6, 1888.

EDITOR ENGINEERING NEWS:

The route from the present end of track, 18 miles northwest of Marshall to Paris (about 95 miles. ED.), has been located and will be put under construction at an early date. No work was done on construction during last year.

JOHN MARTIN, *President* M. P. & N. W. Ry. Co.

Chicago, Kansas & Nebraska.—On the 816 miles built during 1887, about 70 iron spans were erected from 50 to 187 ft. in length. The largest bridge was across the Kaw river at Topeka, 1,000 ft. in length.

Central Missouri.—

Room 518, Roe Building.
KANSAS CITY, MO., Feb. 6, 1888.

EDITOR ENGINEERING NEWS:

Track was laid in 1887 on this road from St. Charles, Mo., 10 miles west. The line is graded and ties have been delivered for 12 miles more, and rails will be laid as soon as spring opens. The whole line has been carefully surveyed from Alton and St. Louis to Kansas City, about 300 miles, and the portion from St. Charles to Fayette, 150 miles, will be built at an early date. Two large bridges are projected; one across the Mississippi river, at Alton, 2,600 ft. in length, and one at Arrow Point, across the Missouri, 1,300 ft. long.

J. T. K. HAYWARD,
Chief Engineer and General Manager.

Cape Girardeau Southwestern.—Surveyors are still at work on the extension to Wellsdale, Mo., to connect with the Current river extension of the Fort Scott & Gulf system. The first preliminary line run had one 1,000 ft. tunnel through a hill of difficult material, and other lines are now being run to avoid this ridge. Contracts are to be let as soon as the location is completed.

New Projects and Surveys.

Hutchinson, Ashland & Neutral Strip.—This company has been incorporated in Kansas, by THOS. E. BERRY and others, of Ashland.

Galveston Jetty.—This company whose incorporation was reported last week, has already secured subscriptions for the full amount of its capital stock. The line will be built along the top of the jetty and used in its construction, and when completed, should the hoped for deep water fail to be secured, cars can be run out to the end of the jetty, and ships be loaded directly from them.

Plattsburg & Kansas City.—A narrow gauge railway is proposed from Plattsburg, Mo., to Randolph, and thence over the bridge and tracks of the Chicago, Milwaukee & St. Paul to Kansas City, a total distance of about 30 miles.

Kansas Valley.—This company held its annual meeting February 7, and elected THOS. A. OSBORNE, of Topeka, President; JOHN K. WRIGHT, of Junction City, Vice-President, and A. L. BARNES, of Junction City, Secretary. The proposed line of the company is from Kansas City to Denver.

Chicago, Kansas & Southwestern.—

HIAWATHA, Kan., Feb. 6, 1888.

EDITOR ENGINEERING NEWS:

The Chicago, Kansas & Southwestern railroad is to run from Parnell, Mo., on the Chicago, St. Paul & Kansas City Ry., *via* Rulo, Hiawatha and Emporia to Arkansas City, about 300 miles. Work is generally light. Surveying has been done and right of way is being secured. Mr. A. J. Schilling is President of the company.

GEO. BOONE, *Secretary.*

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

St. Paul, Minneapolis & Manitoba.—Trains are now running over the new bridge over the Missouri at Great Falls, Montana. The bridge is 990 ft. long and is the only bridge across the Missouri above the Northern Pacific crossing at Bismarck, Dakota.

Southern Pacific.—The company has purchased the Eel River & Eureka Railroad extending from Eureka, Humboldt county, Cal., 45 miles up the Eel river valley. The road has no connection with existing systems and was originally built for transporting lumber to the coast. It is probable that the company will soon turn its attention to the undeveloped region of Northern California and will build into Humboldt county to connect with its new purchase.

Vancouver, Klickitat & Yakima.—Work has begun on the first 10 miles now under contract on this Washington Territory road. This division is to be completed by June 1. R. A. HABERSHAM of Vancouver is Chief Engineer.

Union Pacific.—It is reported that a branch of the Kansas Pacific is to be built from Kit Carson, Col., to Las Animas in order to gain direct connections with Pueblo.

Missouri Pacific.—It is reported that the company has recently secured 3,000 acres of coal lands about 30 miles from Pueblo.

California Central.—Trains are now running over the San Diego extension as far as San Juan Capistrano.

Interoceanic.—This Mexican road which is to run to Vera Cruz, has now about 2,000 hands engaged on its construction and will probably reach Pueblo in May.

New Projects and Surveys.

Pueblo, Gunnison & Pacific.—This company is being organized by business men of Pueblo, Col. The proposed line is to run from Pueblo west through the Masco and Cochetope passes and *via* the Saguache and Gunnison valleys. The object of the enterprise is to induce some of the trunk lines who are pushing west to Pueblo to develop the country west of there and eventually make Pueblo a point on a through transcontinental line.

Rio Grande & Utah.—A strong effort is being made to induce the builders of this proposed line to start from Albuquerque, N. M., instead of Algodones.